

Understanding “Position” in Welding

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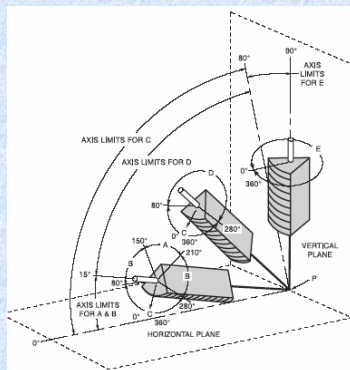
- The primary purpose of this presentation is twofold:
 - Make sure that code users understand the difference between testing positions and production welding positions
 - Help users understand how to read the figures that define production welding positions shown on the next page.

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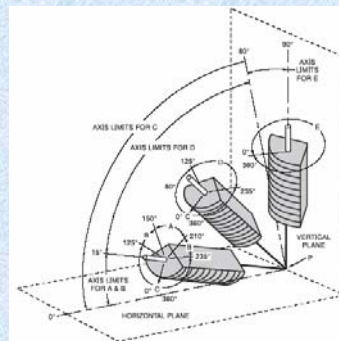
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Production Welding Positions

Groove Welds



Fillet Welds



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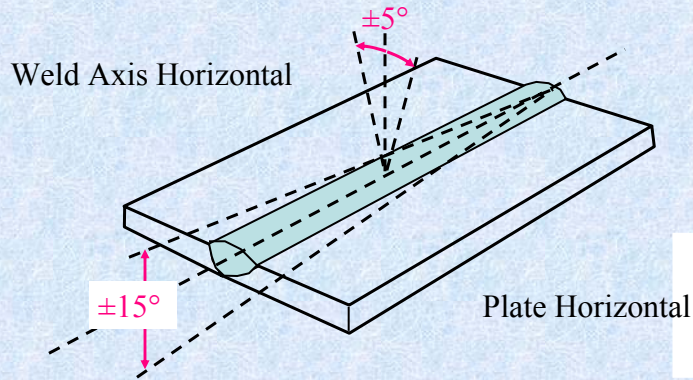
Standard Test Positions

Positions 1G, 3G, 6G, 2F, 5F, etc. are specially defined standard positions used for testing. They are properly referred to as Test Positions. Similar positions are found in ISO 6947 identified as PA, PC, PG, etc.

Standard Testing Positions

Test positions are discreetly defined positions of test coupons that are used when mostly when testing welders. These positions have tolerance of $\pm 15^\circ$ from the defined horizontal planes and $\pm 5^\circ$ from a defined vertical or inclined plane. See QW-120

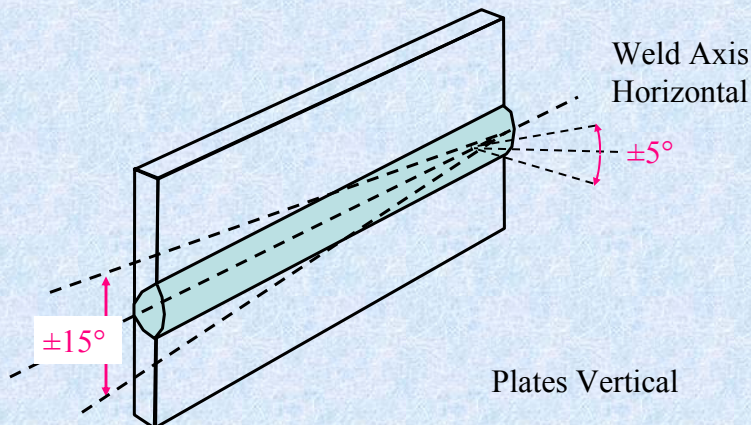
Testing Position 1G/PA



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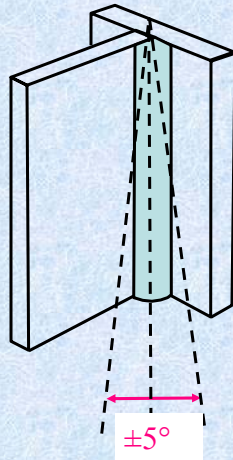
Test Position 2G/PC



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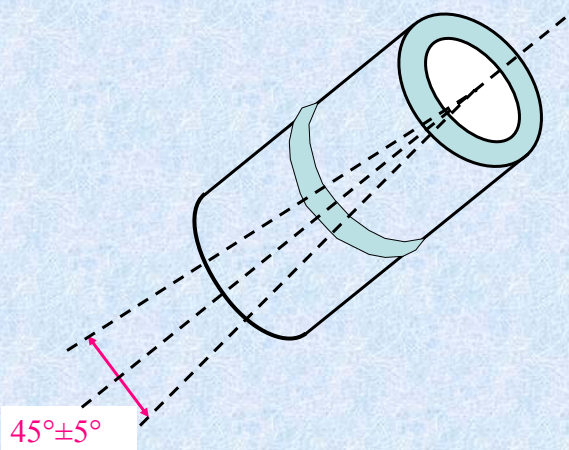
Test Position 3F/PF or PG



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Test Position 6G/HL045 or JL045



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Test Positions are Discreetly Defined

- Because of tolerance limits on test positions, positions in between test positions are undefined!
- That is, a weld that is inclined 22° uphill and rotated 36° about its axis has no “G” or “F” position. Such a position, however, may be encountered during production welding.
- Production welding positions, therefore, need to be defined contiguously.

Test Positions Qualify Welders for Specific Welding Positions

Test Positions → Welding Positions

Translations from test positions to welding positions are made in the construction codes. QW-461.9 is typical.

Test Positions → Welding Positions

Qualification Test		Position and Type Weld Qualified [Note (1)]		
		Groove		
Weld	Position	Plate and Pipe Over 24 in. (610 mm) O.D.	Pipe ≤ 24 in. (610 mm) O.D.	Fillet Plate and Pipe
Plate — Groove	1G	F	F [Note (2)]	F
	2G	F,H	F,H [Note (2)]	F,H
	3G	F,V	F [Note (2)]	F,H,V
	4G	F,O	F [Note (2)]	F,H,O
	3G and 4G 2G, 3G, and 4G Special Positions (SP)	F,V,O All SP,F	F [Note (2)] F,H [Note (2)] SP,F	All All SP,F
Plate — Fillet	1F	...	...	F [Note (2)]
	2F	...	...	F,H [Note (2)]
	3F	...	...	F,H,V [Note (2)]
	4F	...	...	F,H,O [Note (2)]
	3F and 4F Special Positions (SP)	...	...	All [Note (2)] SP,F [Note (2)]
Pipe — Groove [Note (3)]	1G	F	F	F
	2G	F,H	F,H	F,H
	5G	F,V,O	F,V,O	All
	6G	All	All	All
	2G and 5G Special Positions (SP)	All SP,F	All SP,F	All SP,F
Pipe — Fillet [Note (3)]	1F	F
	2F	F,H
	2FR	F,H
	4F	F,H,O
	5F Special Positions (SP)	All SP,F

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Welding Positions

Note to table:

(1) Positions of welding as shown in QW-461.1 and QW-461.2

F = Flat

H = Horizontal

V = Vertical

O = Overhead

(2) Pipe 2-7/8 in outside diameter and over.

Welding positions for groove welds are defined by the following diagram.

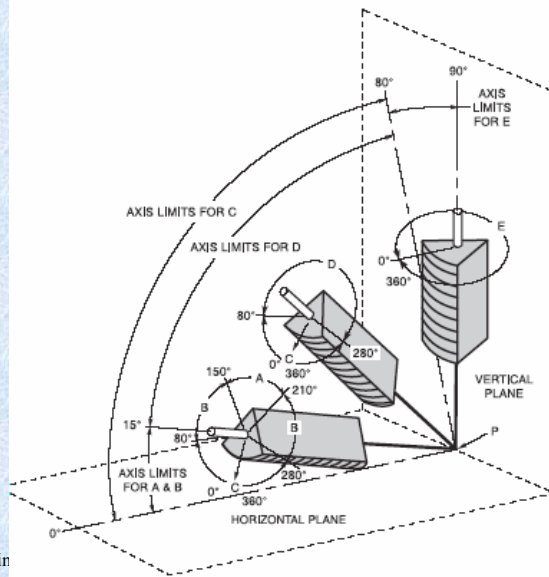
NOTE

Welding Position Diagrams are contiguous.

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Welding Positions for Groove Welds



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Tabulation showing transition points between welding positions

Tabulation of Positions of Groove Welds

<u>Position</u>	<u>Diagram Reference</u>	<u>Inclination of Axis</u>		<u>Rotation of Face</u>
Flat	A	0 to 15°		150 to 210°
Horizontal	B	0 to 15°	80 to 150°	210 to 280°
Overhead	C	0 to 80°		0 to 80° 210 to 360°
Vertical	D	15 to 80°		80 to 280°
	E	80 to 90°		0 to 360°

How this table and the diagram on the previous page work are shown in the following diagrams

Let's start with the Flat Position

Welding Positions

Tabulation of Positions of Groove Welds

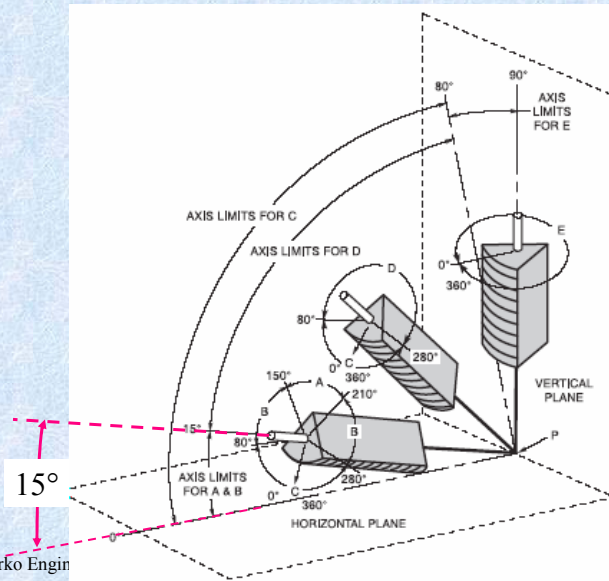
<u>Position</u>	<u>Diagram Reference</u>	<u>Inclination of Axis</u>	<u>Rotation of Face</u>
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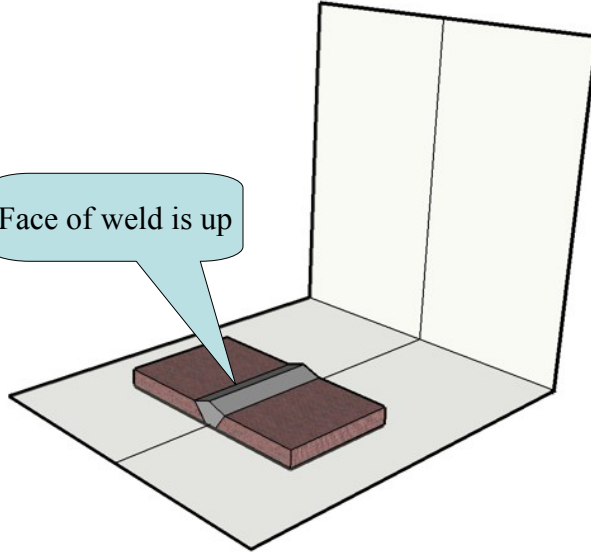
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Flat Positions Axis Inclination



Start at Nominal Flat Position

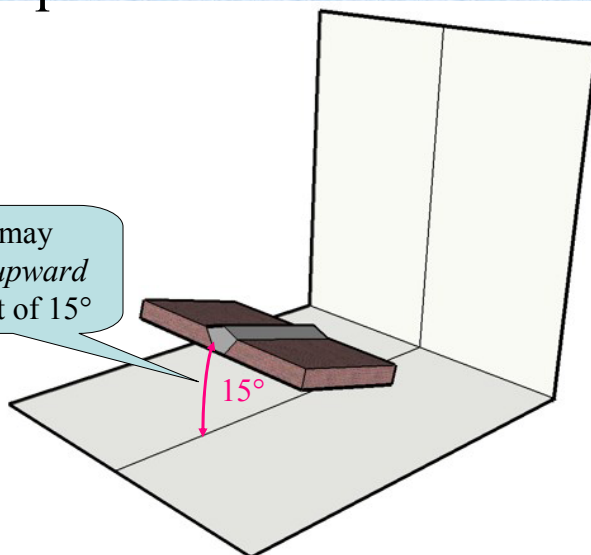
Face of weld is up



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Flat Upward Inclined Limit

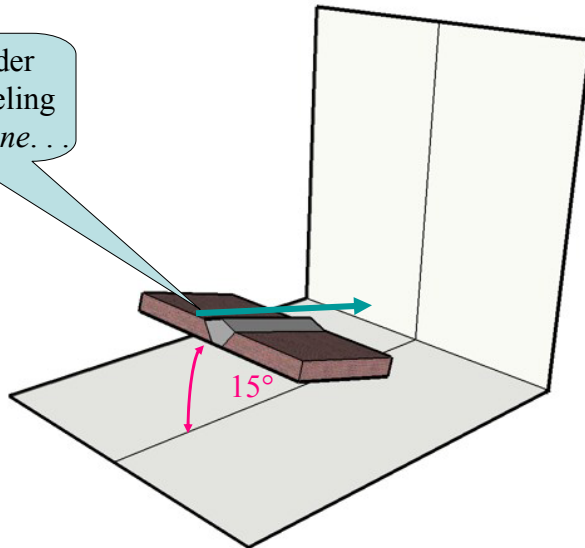
Weld may
incline upward
to a limit of 15°



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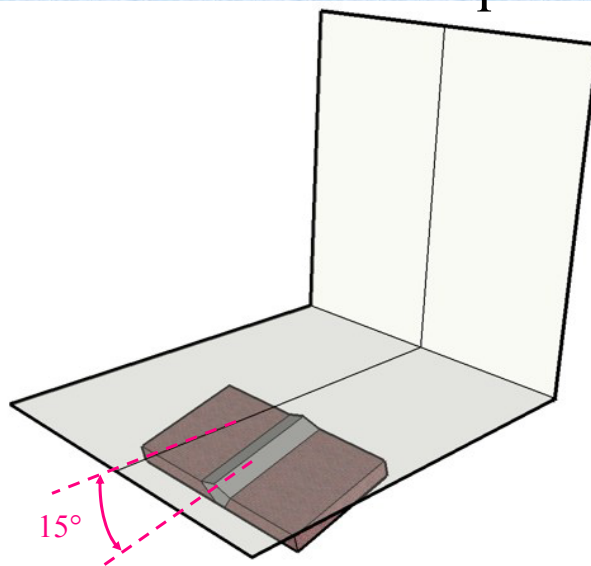
Flat Upward Inclined Limit

But the welder could be traveling *down the incline* . . .



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Flat *Downward* Limit Is Implied



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Welding Positions

Tabulation of Positions of Groove Welds

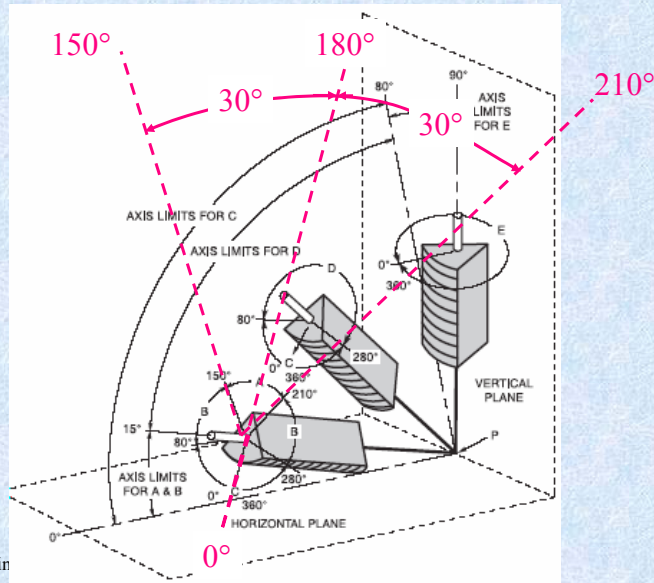
Position	Diagram Reference	Inclination of Axis	Rotation of Face
Flat	A	0 to 15°	150 to 210°
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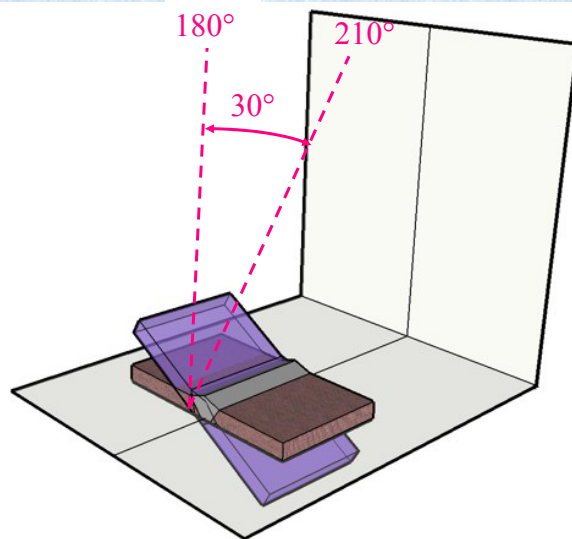
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Flat Position -- Rotation About Axis



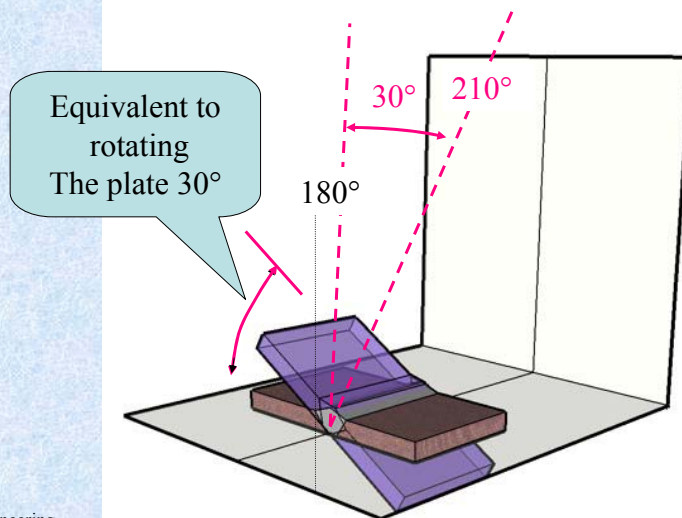
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Flat Rolled Limit Clockwise



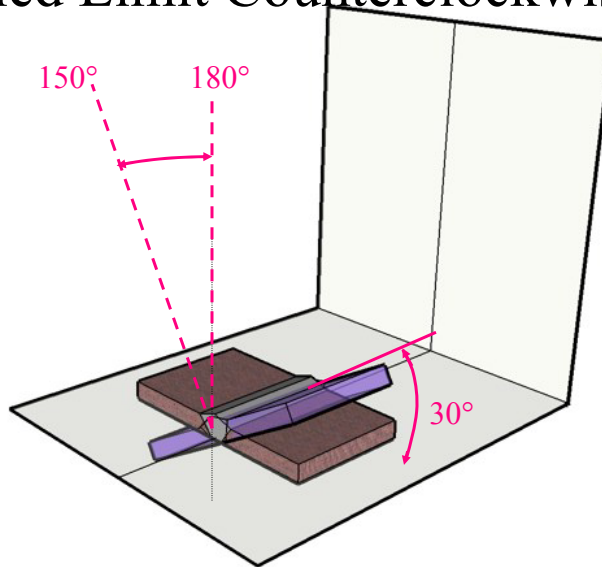
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Flat Rolled Limit Clockwise



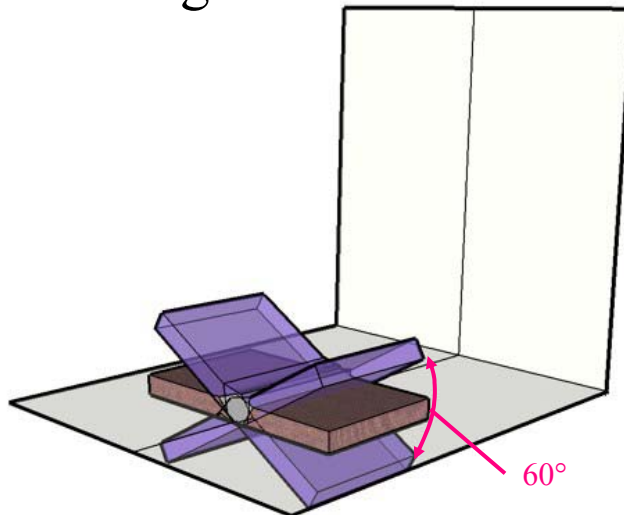
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Flat Rolled Limit Counterclockwise



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Flat Rotated Limits Not Considering Inclination



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Welding Positions

Tabulation of Positions of Groove Welds

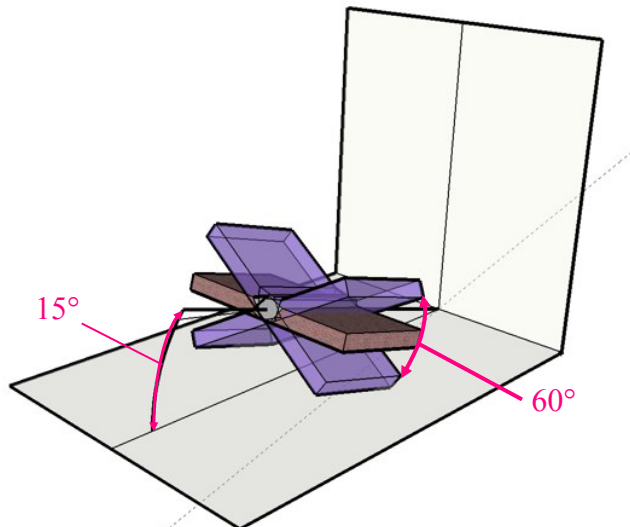
<u>Position</u>	<u>Diagram Reference</u>	<u>Inclination of Axis</u>	<u>Rotation of Face</u>
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How this table and the diagram on the previous page work are shown in the following diagrams

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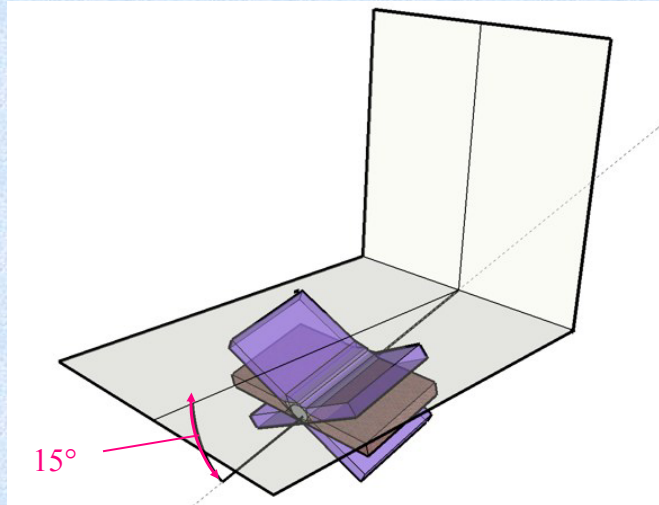
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Flat Uphill Limit Rotated



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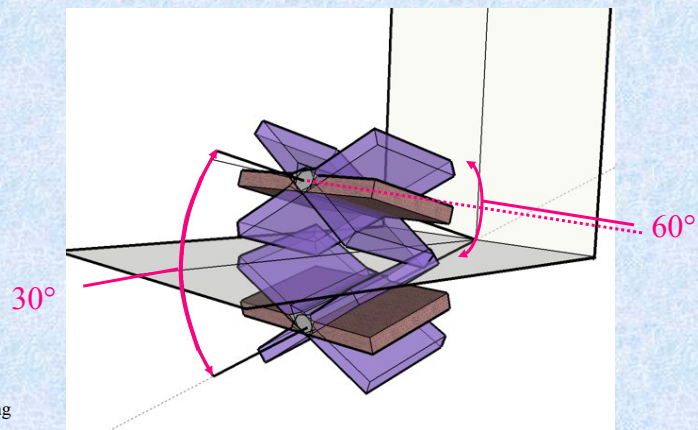
Flat Downhill Limit Rotated



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Composite Flat Position Ranges

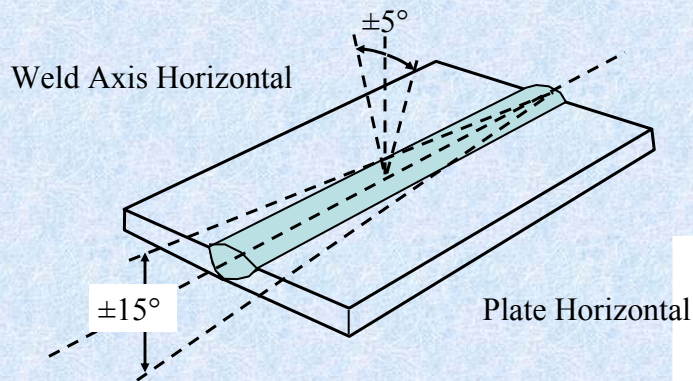


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Compare this range to 1G/PA. . .

Testing Position 1G/PA



Flat \neq 1G !!!!

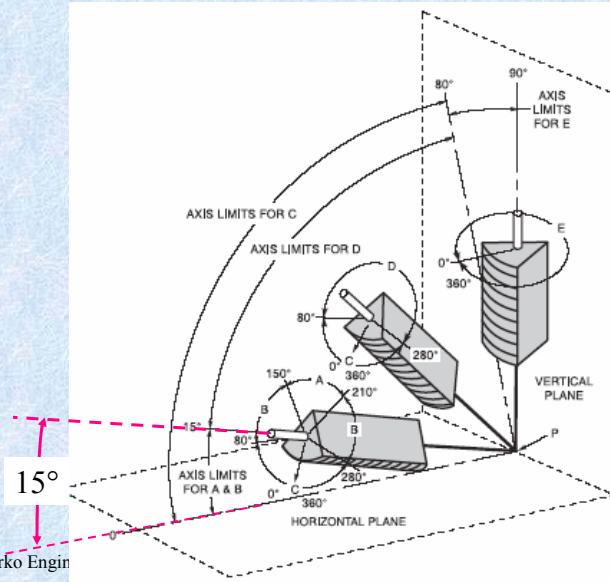
Welding Positions

Tabulation of Positions of Groove Welds

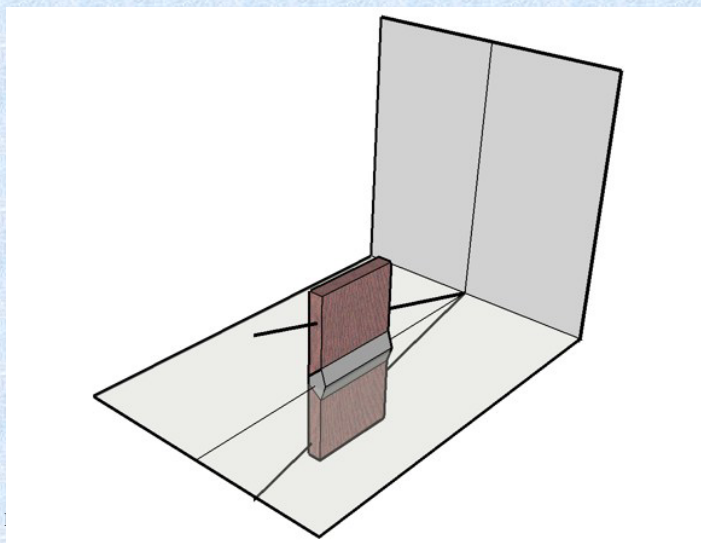
<u>Position</u>	<u>Diagram Reference</u>	<u>Inclination of Axis</u>	<u>Rotation of Face</u>
Flat	A	0 to 15°	150 to 210°
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	E	80 to 90°	0 to 360°

How this table and the diagram on the previous page work are shown in the following diagrams

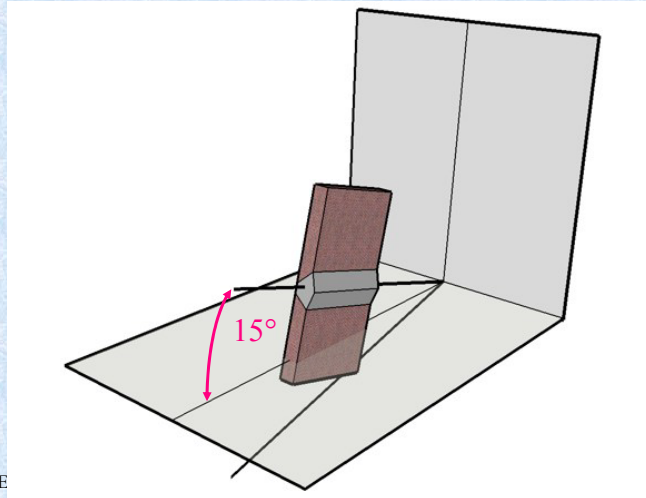
Horizontal Position Axis Inclined



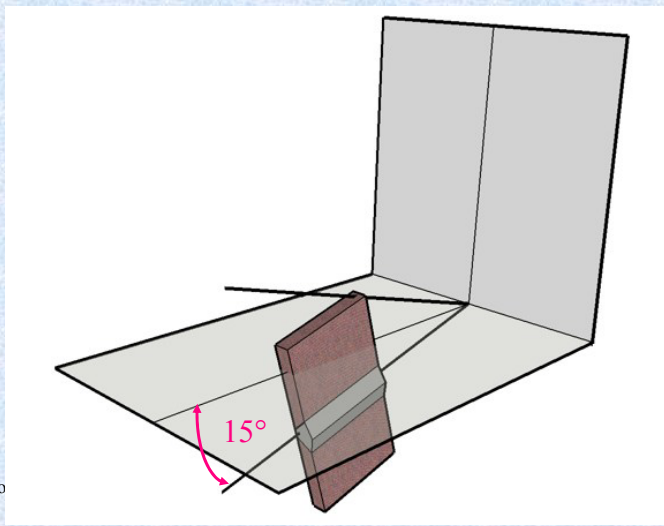
Basic Horizontal Position



Horizontal Position Uphill Inclined Limit



Horizontal Position Downhill Inclined Limit



Welding Positions

Tabulation of Positions of Groove Welds

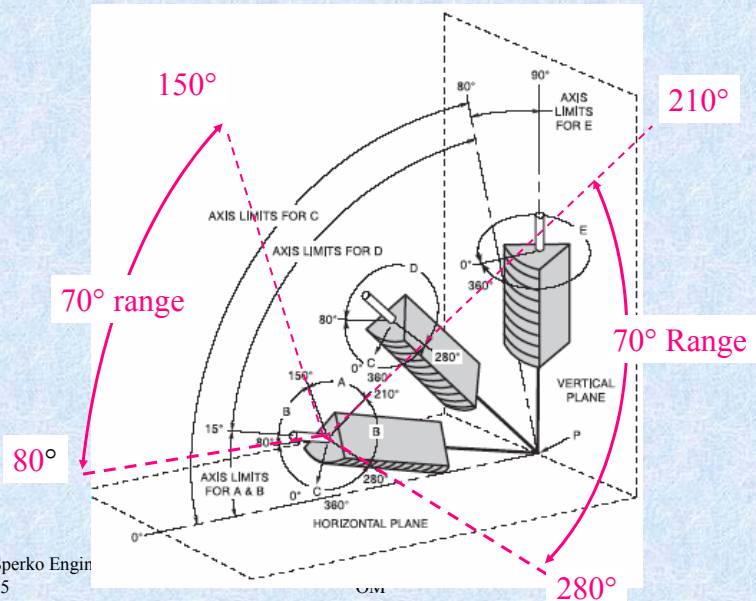
Position	Diagram Reference	Inclination of Axis	Rotation of Face
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How this table and the diagram on the previous page work are shown in the following diagrams

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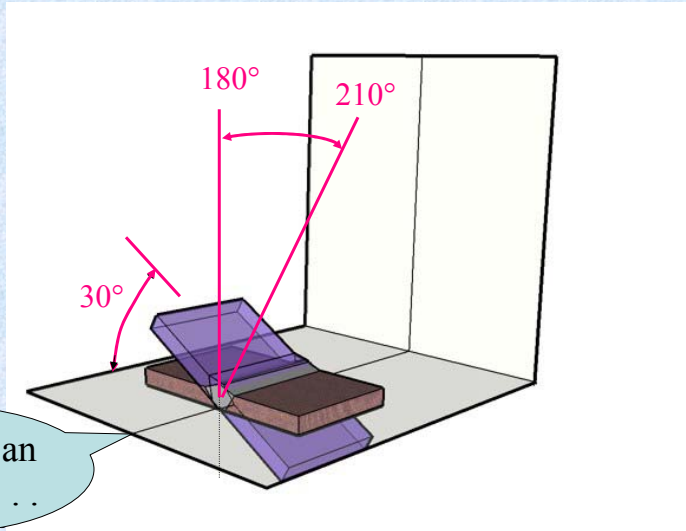
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Horizontal Position Rotated



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Start at the Flat Rolled Limits

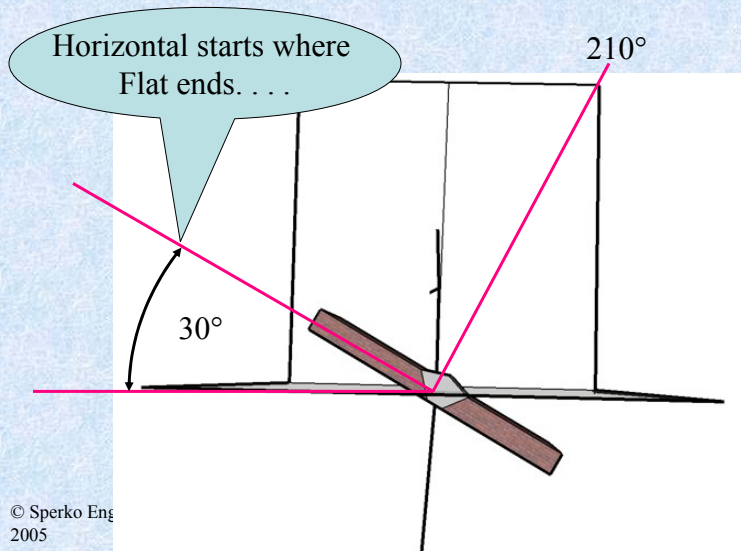


Let's go to an end view. . . .

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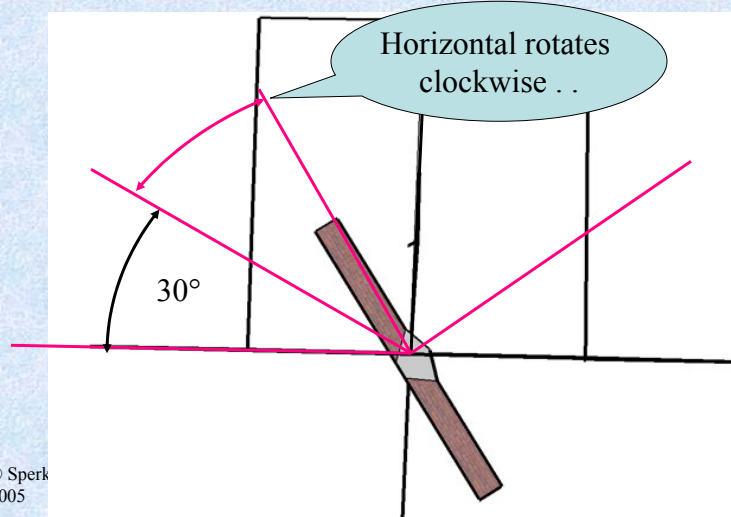
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Horizontal End View

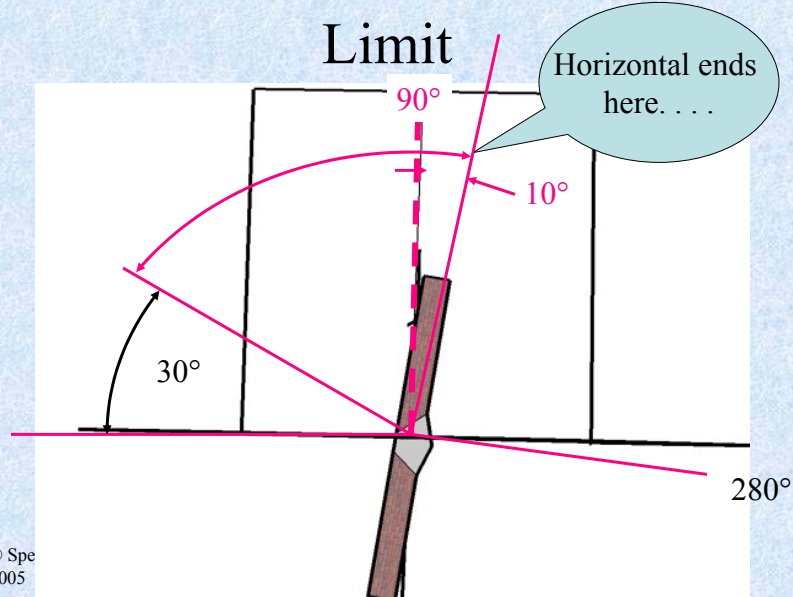


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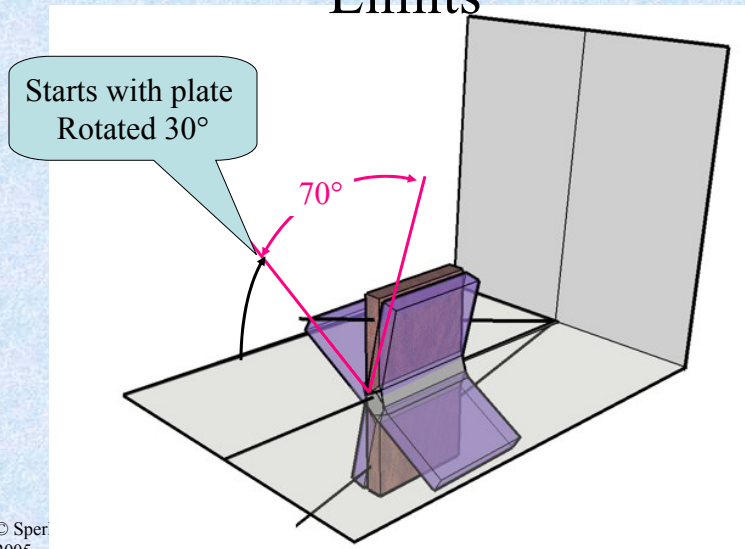
Horizontal Rotates to where the plate is perpendicular to the ground



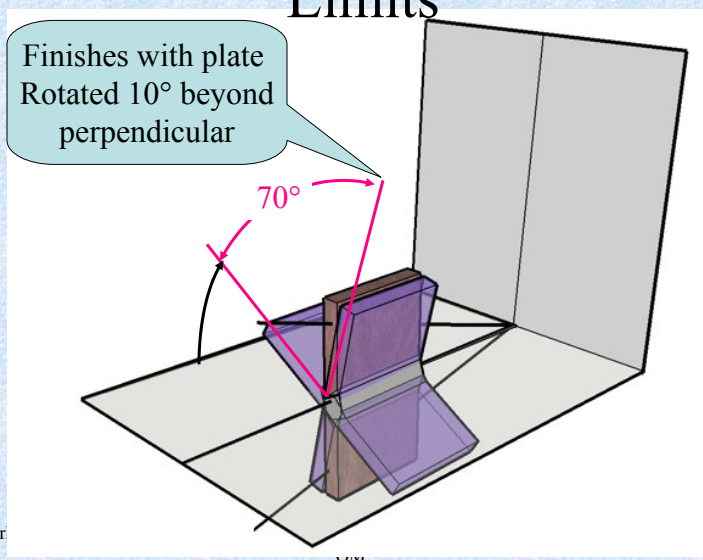
Horizontal Position Rotated
Limit



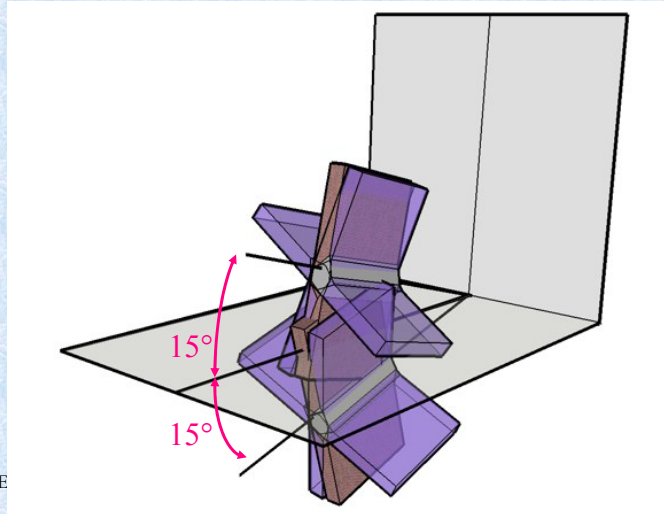
Non-inclined Horizontal Position Limits



Non-inclined Horizontal Position Limits

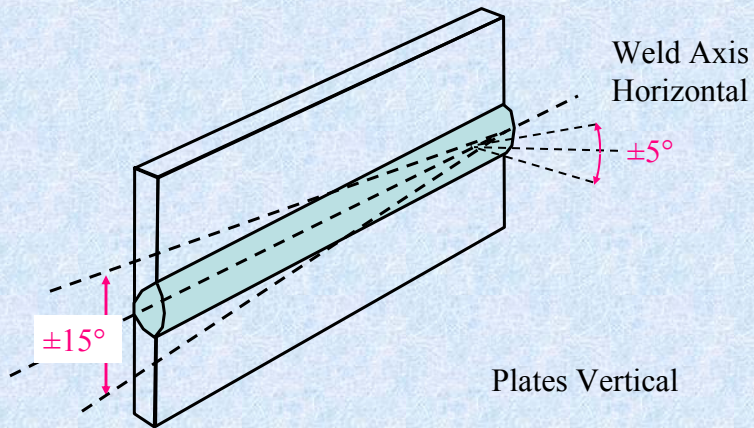


Composite Horizontal Position Limits



Compare Horizontal to 2G/PC

Test Position 2G/PC



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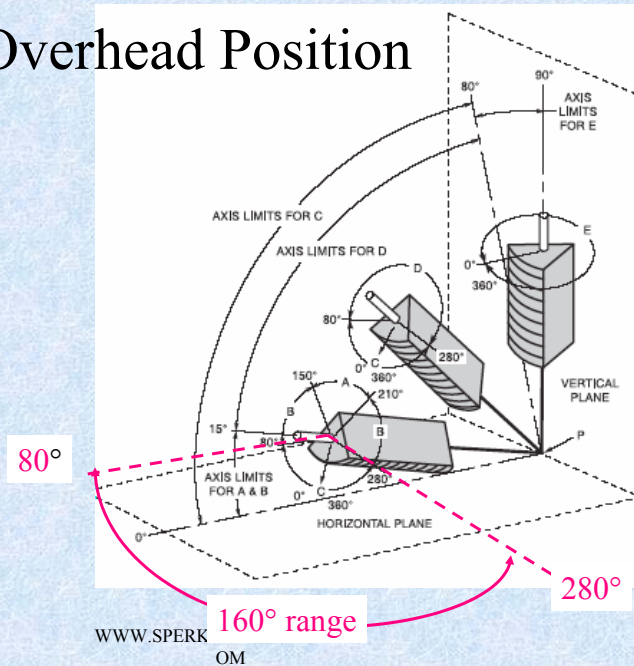
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Horizontal \neq 2G/PC !!!!

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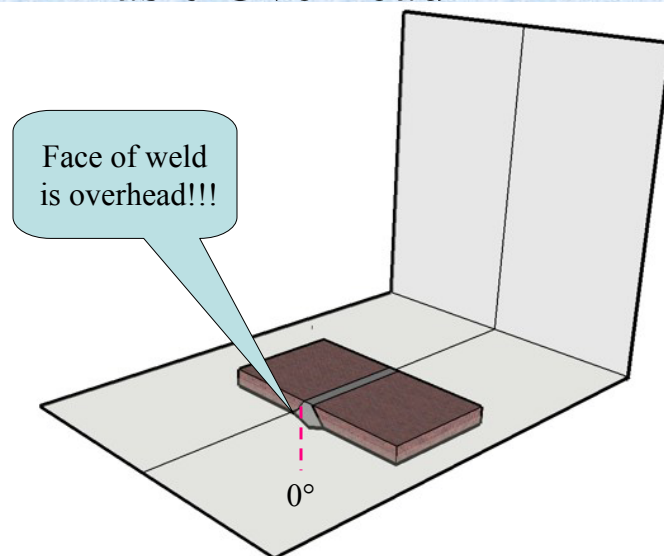
Overhead Position



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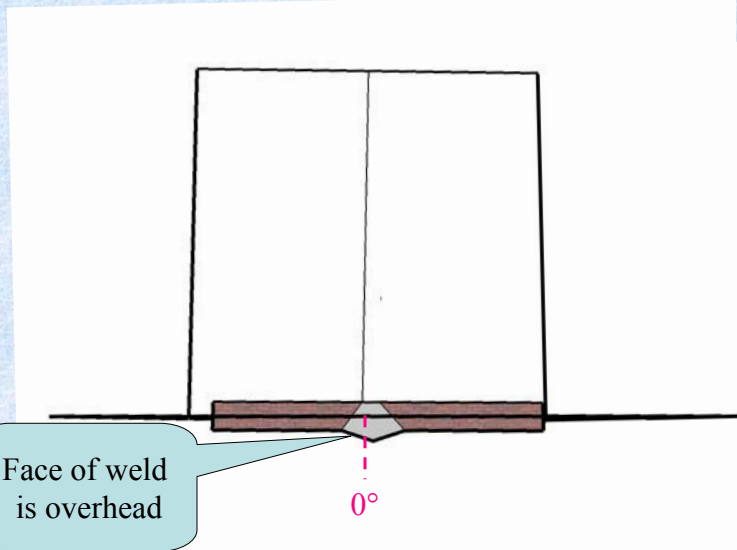
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Basic Overhead

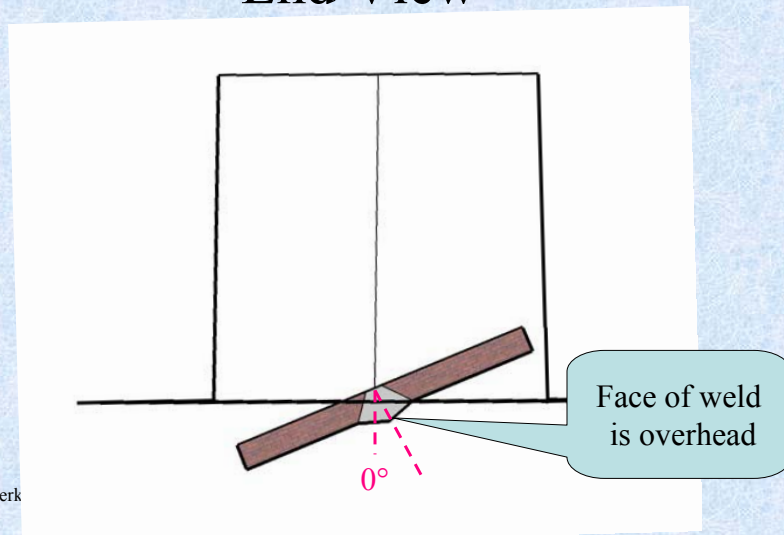


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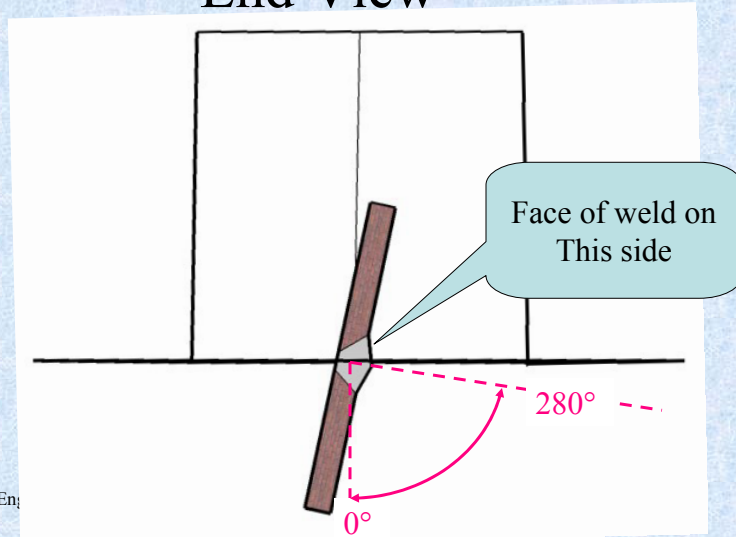
Basic Overhead End View



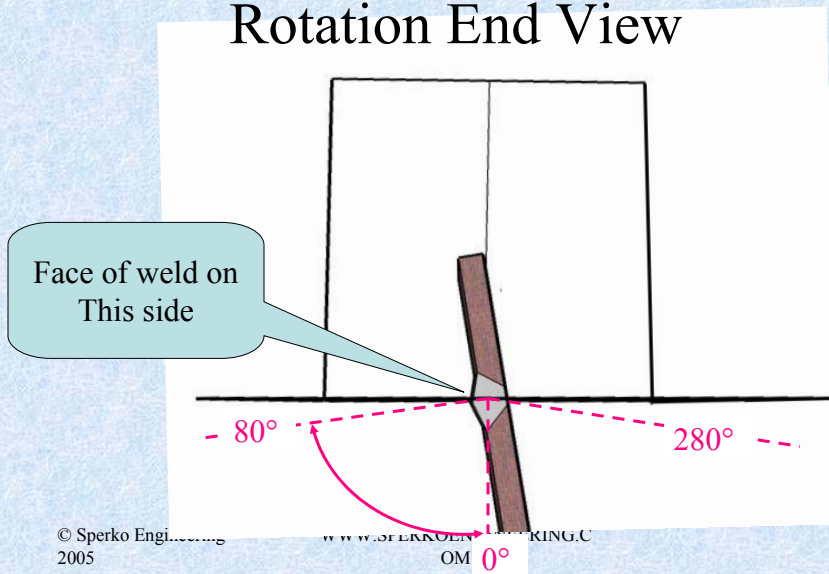
Overhead Partial Rotation End View



Overhead Maximum Rotation End View



Overhead Maximum Opposite Rotation End View

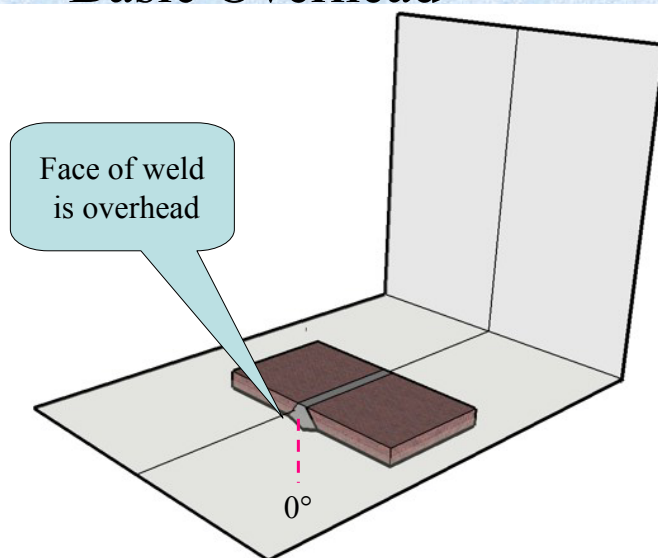


Same Rotation in Isometric View

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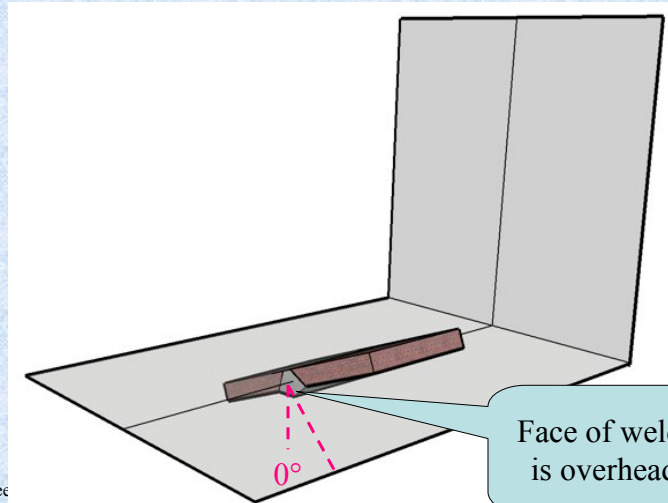
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Basic Overhead



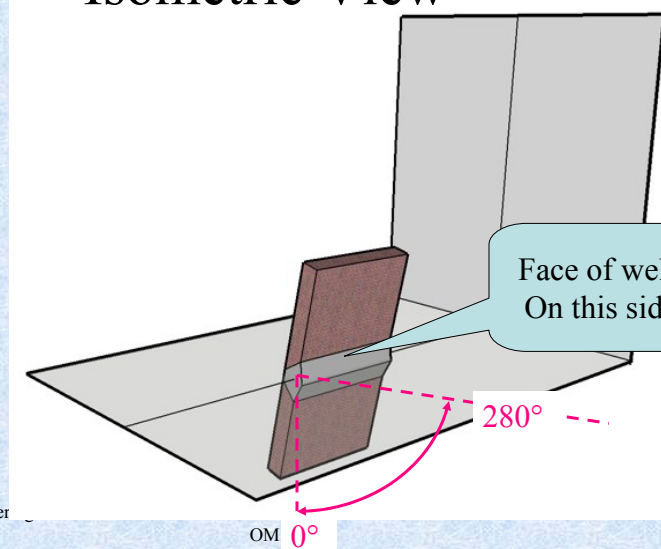
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Overhead Partial Rotation Isometric View



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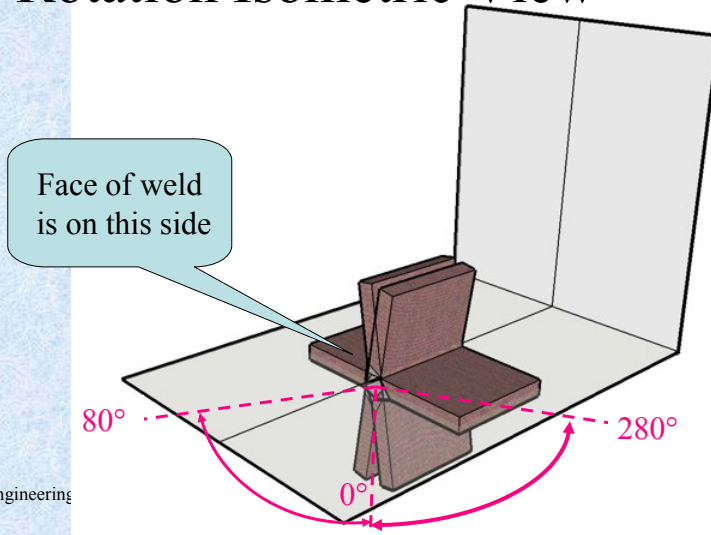
Overhead Maximum Rotation Isometric View



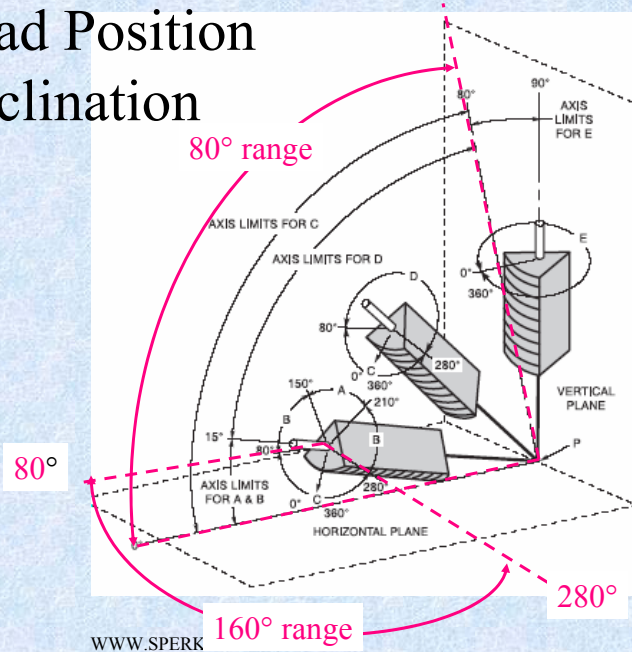
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OM 0°

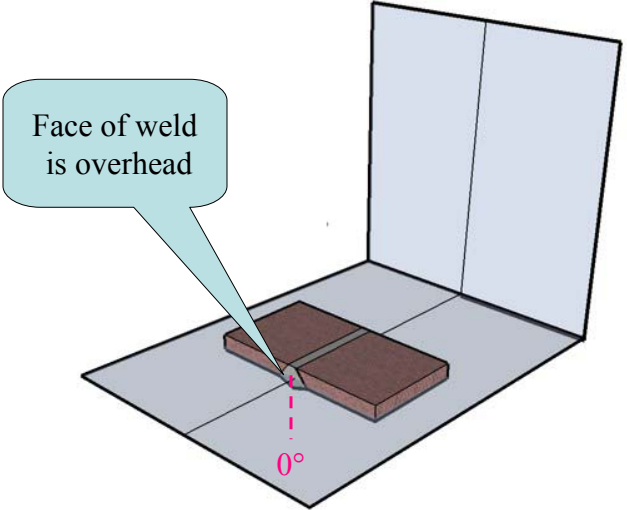
Overhead Maximum Opposite Rotation Isometric View



Overhead Position Axis Inclination

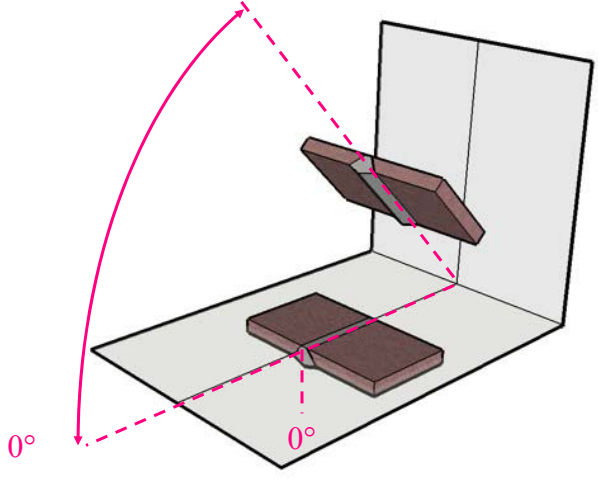


Basic Overhead for Inclined Axis



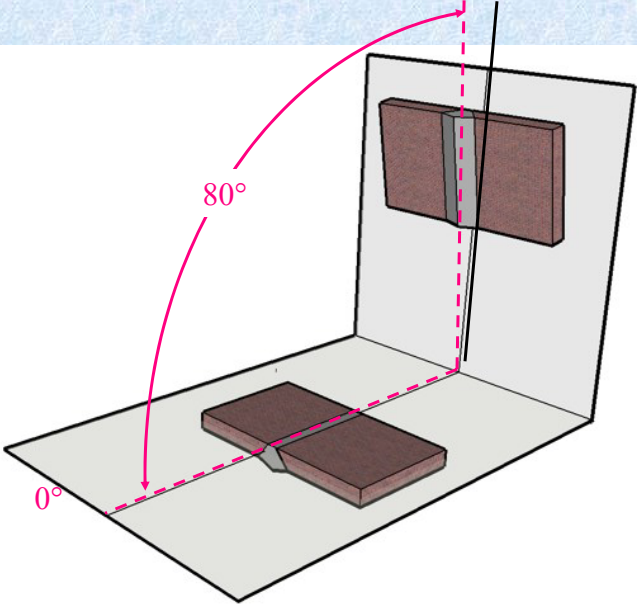
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Overhead Inclined Axis Rotation



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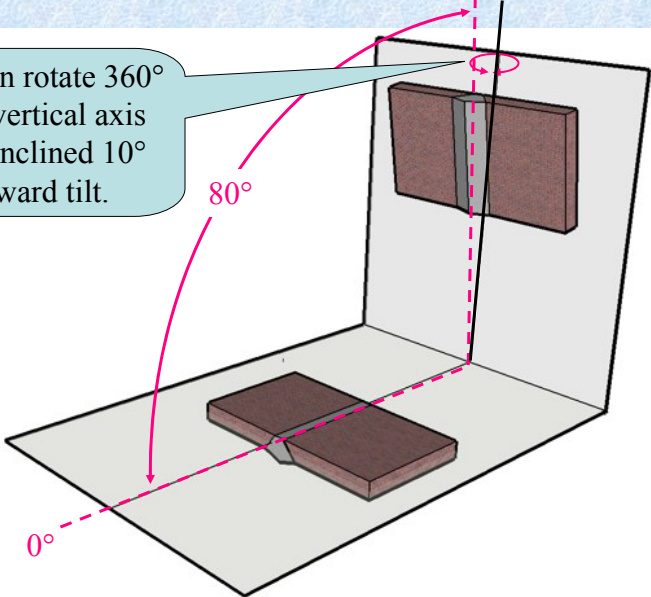
Overhead Inclined Axis Limit



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Overhead Inclined Axis Limit

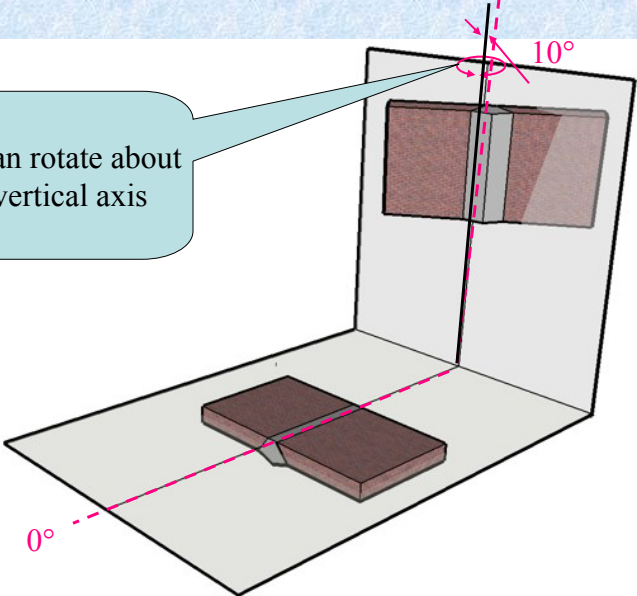
Weld can rotate 360°
about vertical axis
while inclined 10°
forward tilt.



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Overhead Inclined Axis Limit

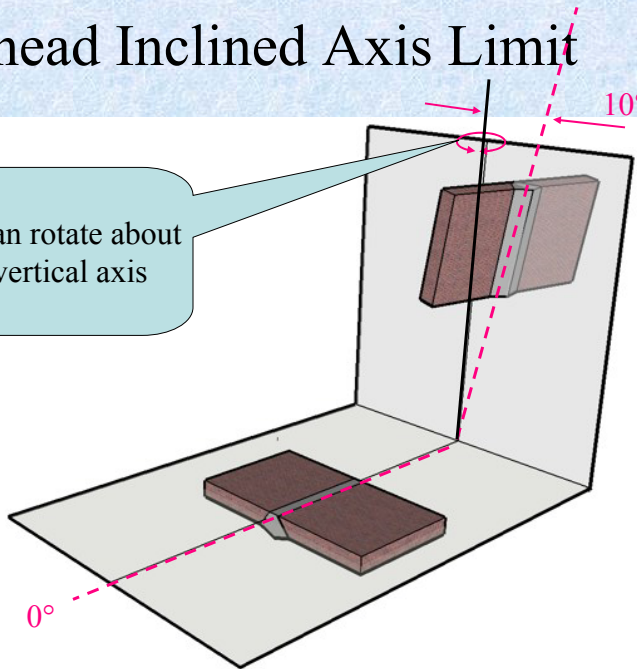
Weld can rotate about
The vertical axis



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Overhead Inclined Axis Limit

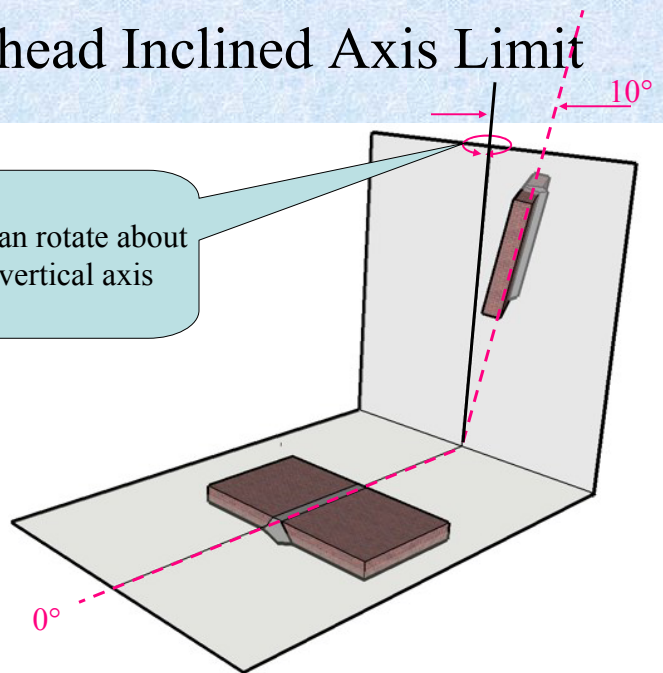
Weld can rotate about
The vertical axis



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Overhead Inclined Axis Limit

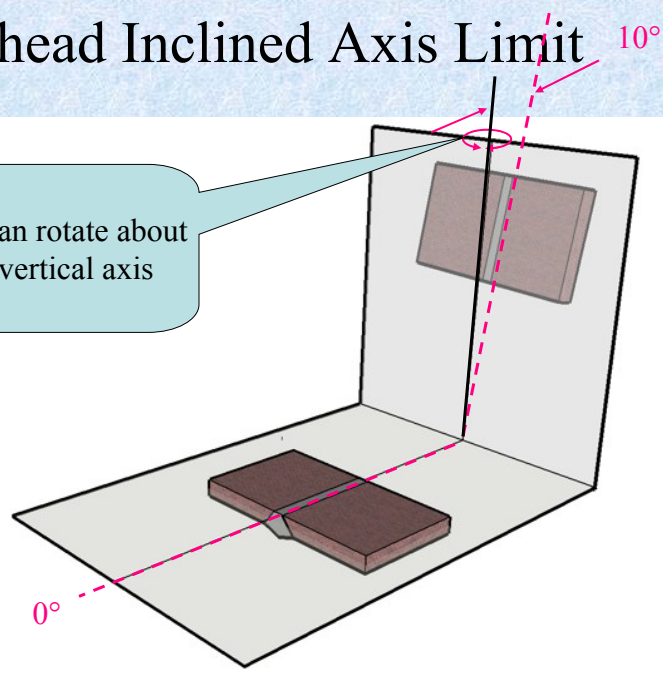
Weld can rotate about
The vertical axis



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Overhead Inclined Axis Limit

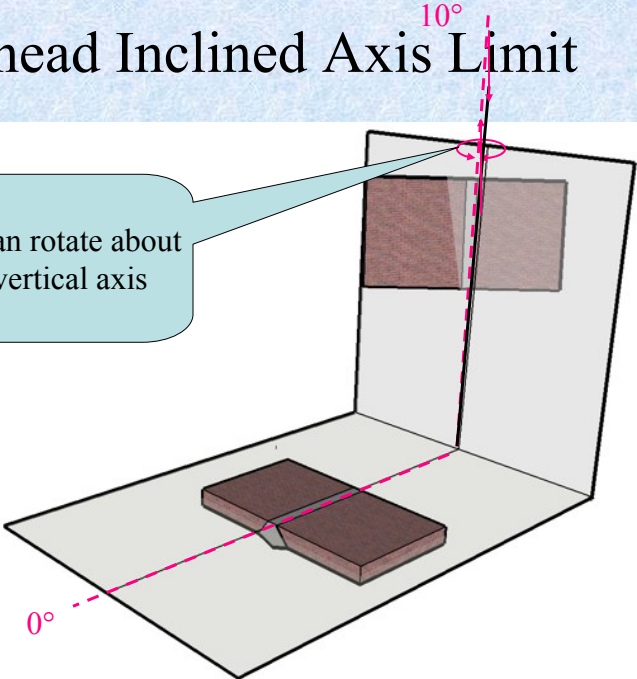
Weld can rotate about
The vertical axis



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Overhead Inclined Axis Limit

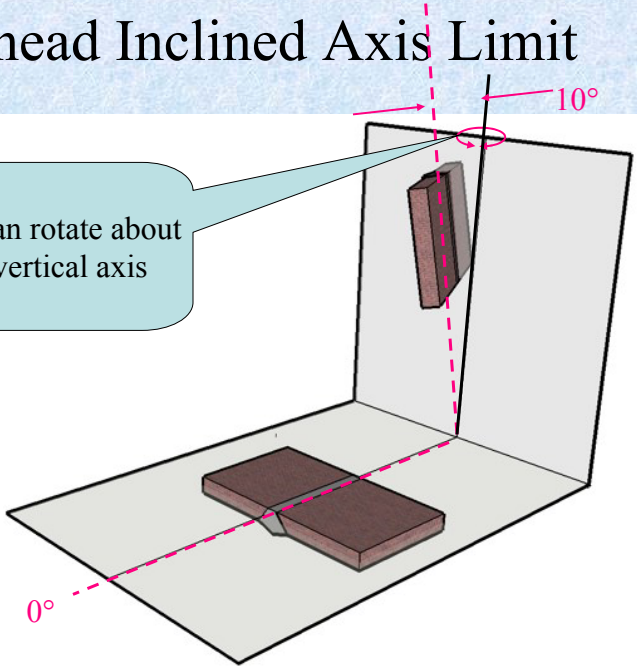
Weld can rotate about
The vertical axis



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Overhead Inclined Axis Limit

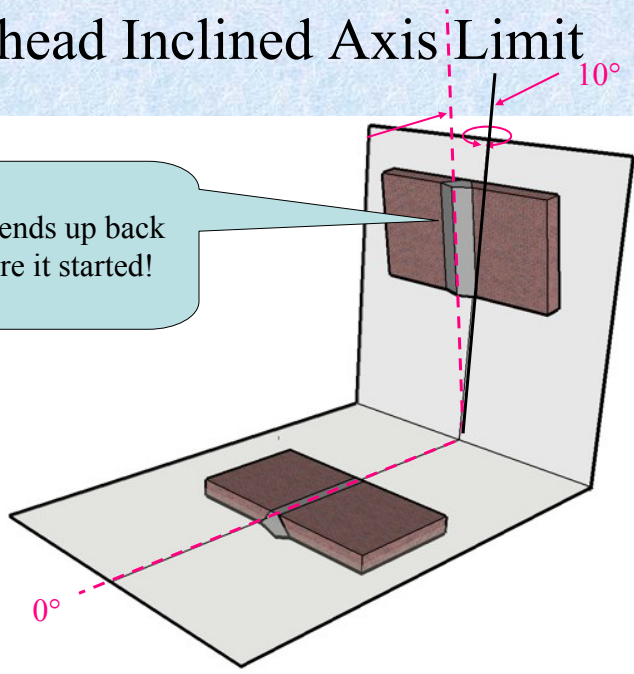
Weld can rotate about
The vertical axis



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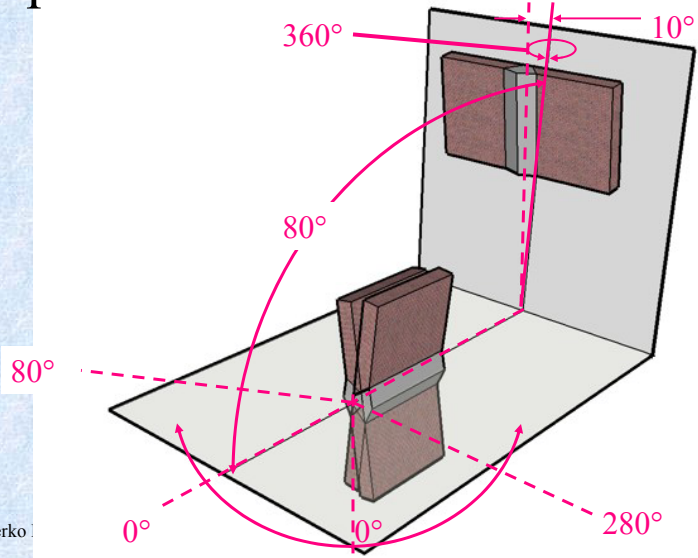
Overhead Inclined Axis Limit

Weld ends up back
Where it started!



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Composite Overhead Position Limits

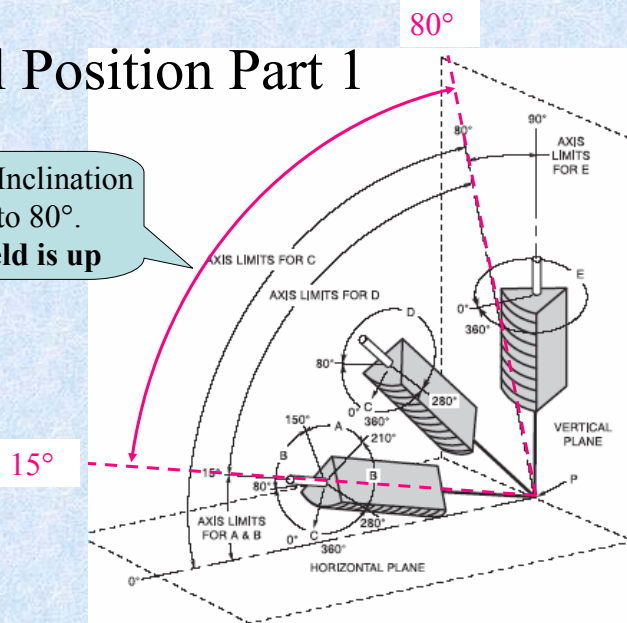


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Overhead \neq 4G/PE !!!!

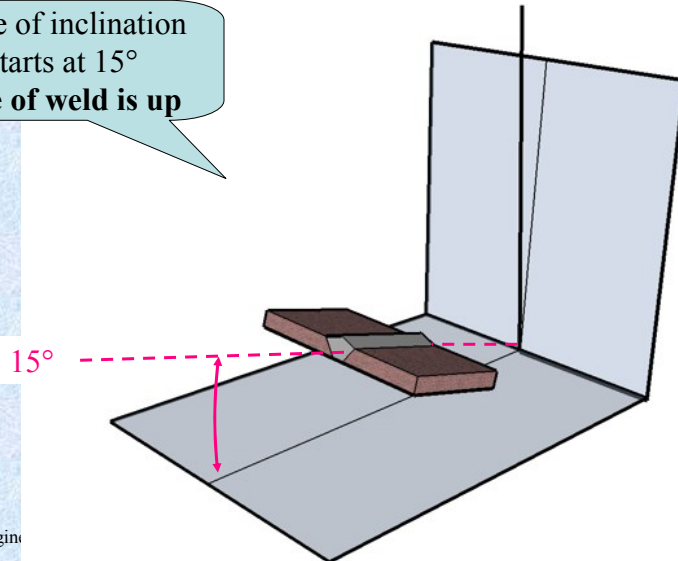
Vertical Position Part 1

65° Range of Inclination
From 15 to 80°.
Face of weld is up



Vertical Position Part 1

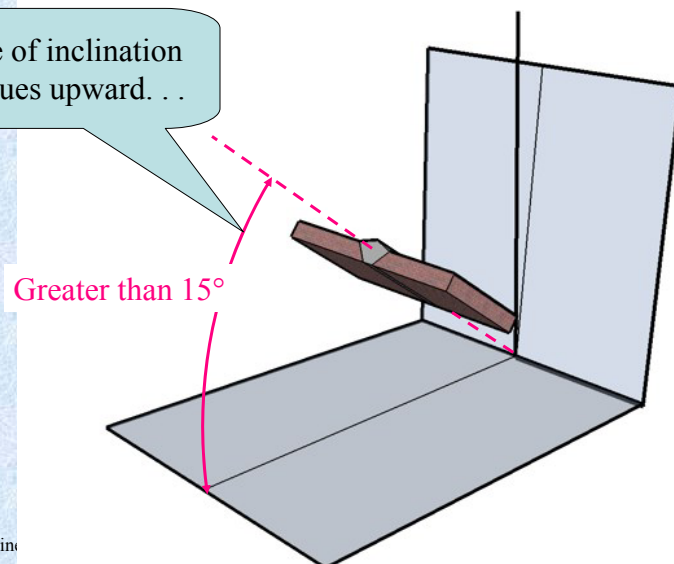
Range of inclination
Starts at 15°
Face of weld is up



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Vertical Position Part 1

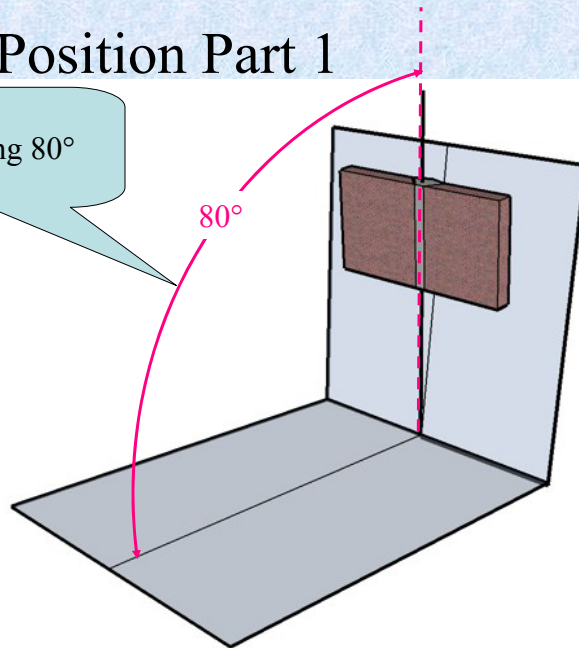
Range of inclination
continues upward. . .



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Vertical Position Part 1

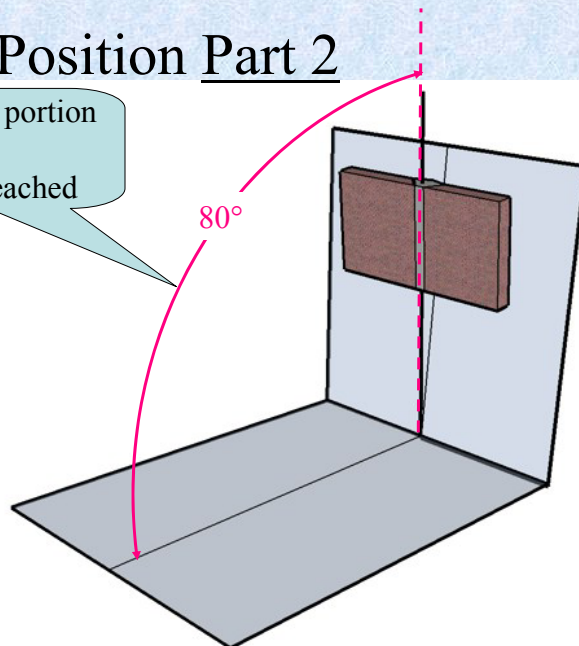
Until reaching 80°



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Vertical Position Part 2

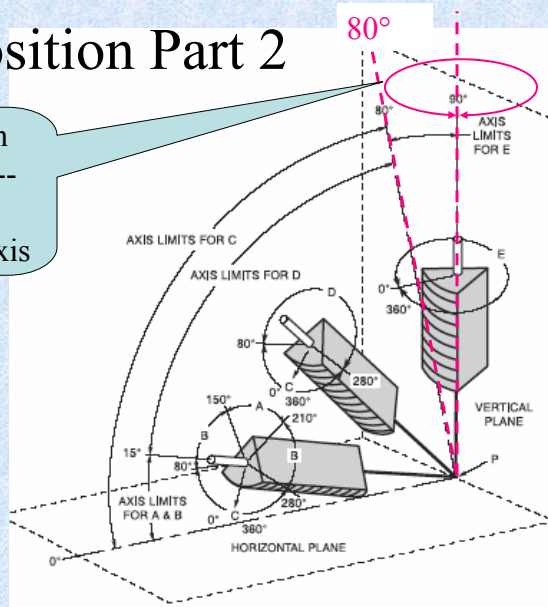
When the "E" portion
of the
diagram is reached



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Vertical Position Part 2

The "E" portion of the diagram --
360° Rotation
About vertical axis

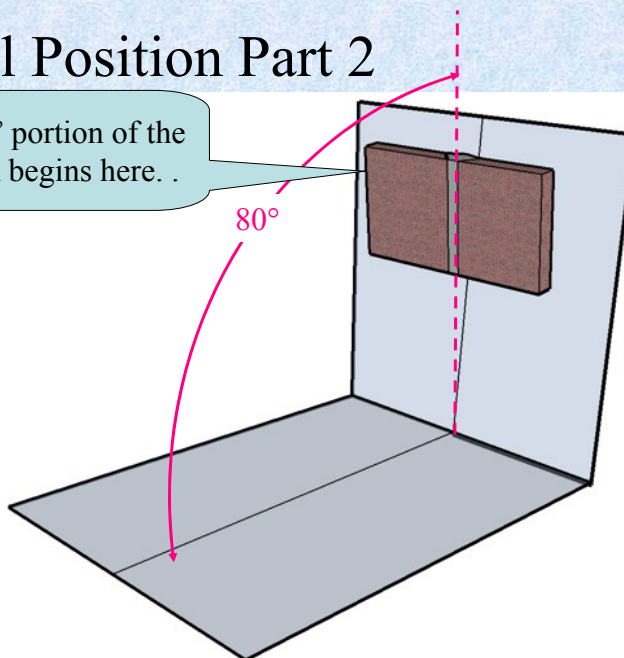


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Vertical Position Part 2

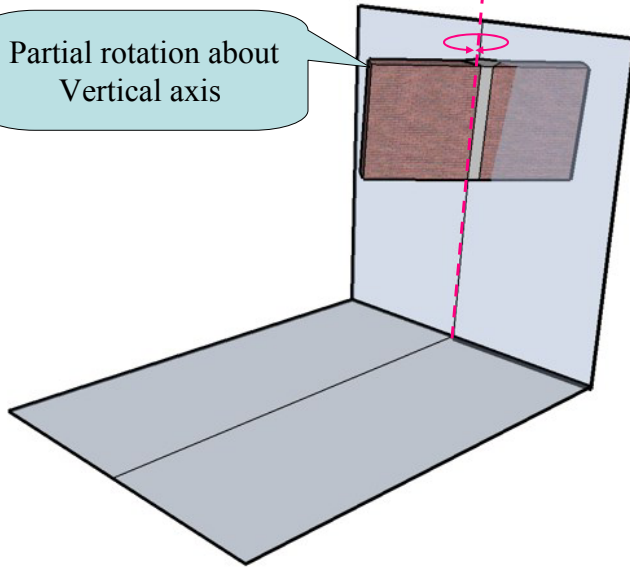
The "E" portion of the diagram begins here. .



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Vertical Position Part 2

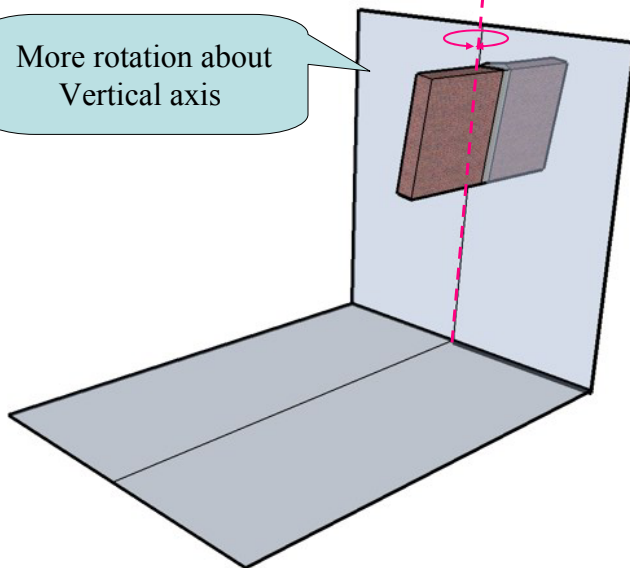
Partial rotation about
Vertical axis



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Vertical Position Part 2

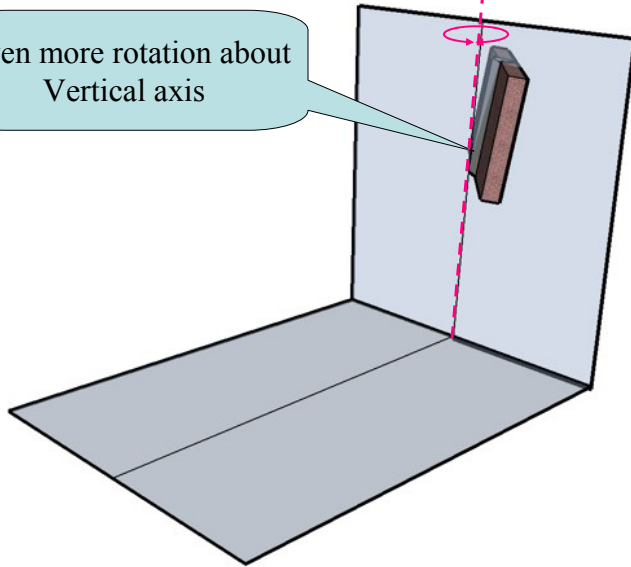
More rotation about
Vertical axis



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Vertical Position Part 2

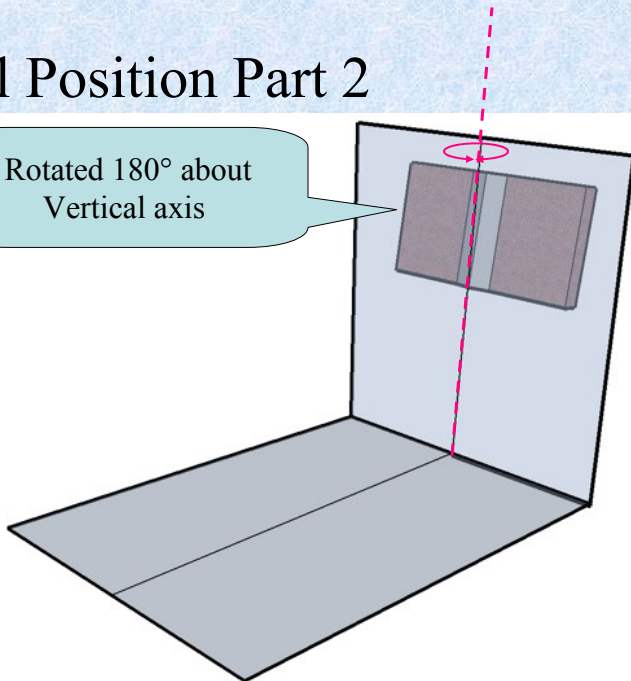
Even more rotation about Vertical axis



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Vertical Position Part 2

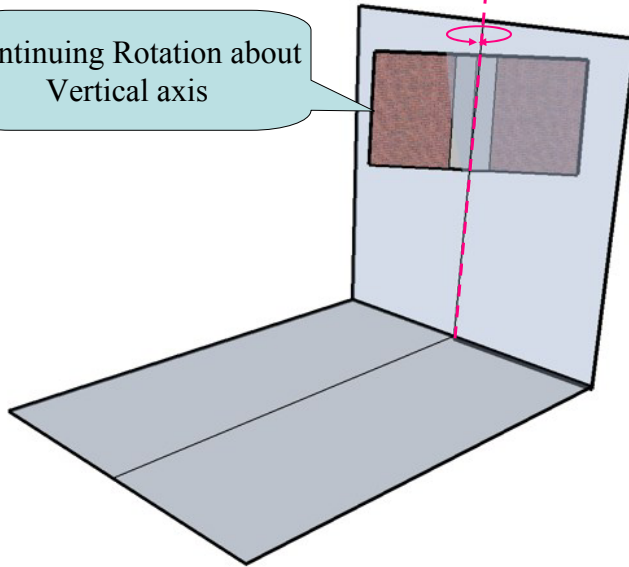
Rotated 180° about Vertical axis



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Vertical Position Part 2

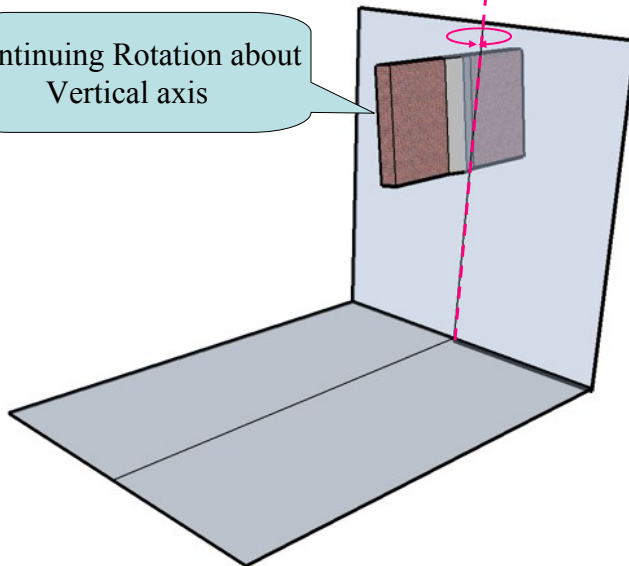
Continuing Rotation about Vertical axis



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Vertical Position Part 2

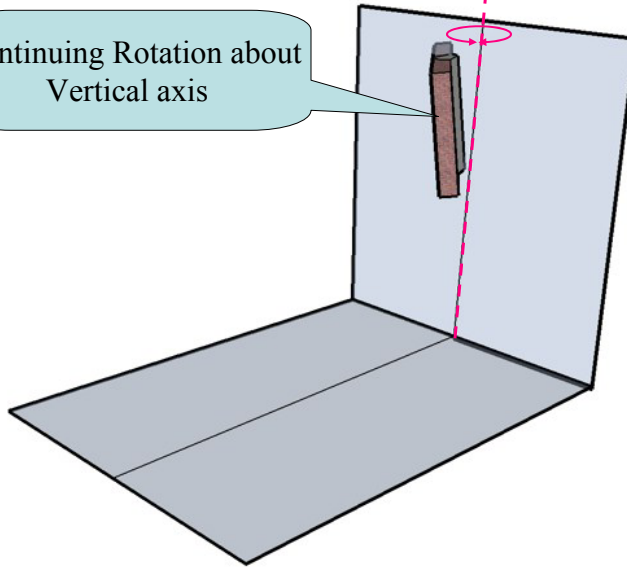
Continuing Rotation about Vertical axis



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Vertical Position Part 2

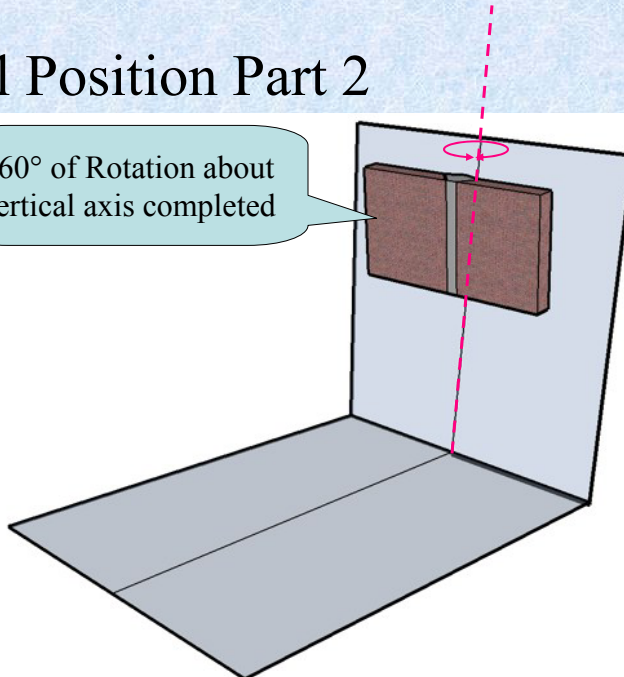
Continuing Rotation about Vertical axis



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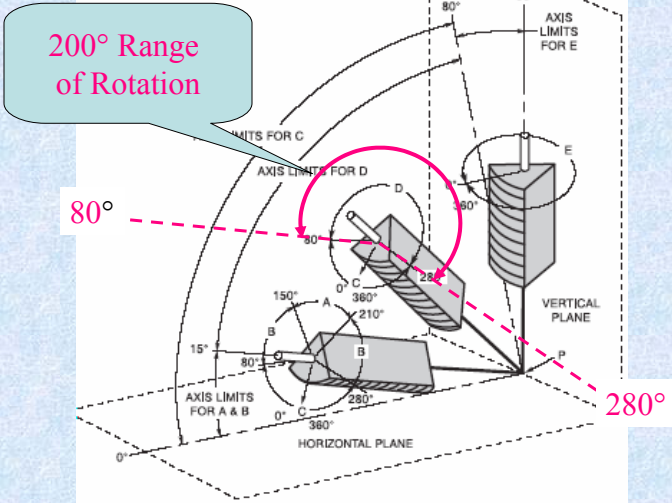
Vertical Position Part 2

360° of Rotation about Vertical axis completed



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Vertical Position Part 3



200° Range of Rotation

80°

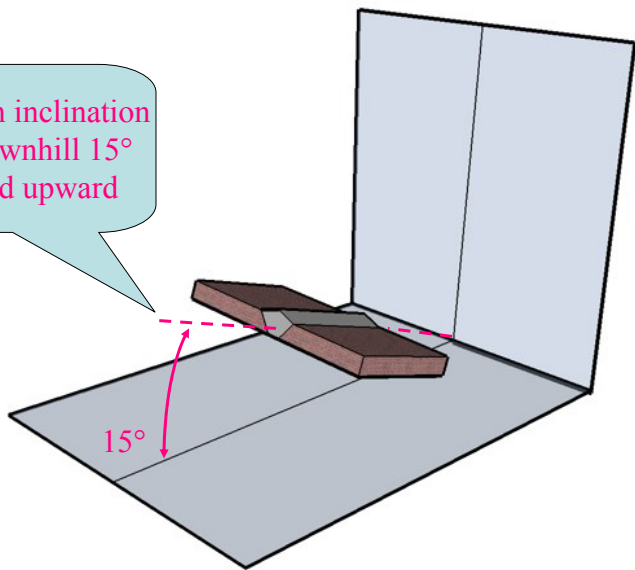
280°

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Vertical Position Part 3

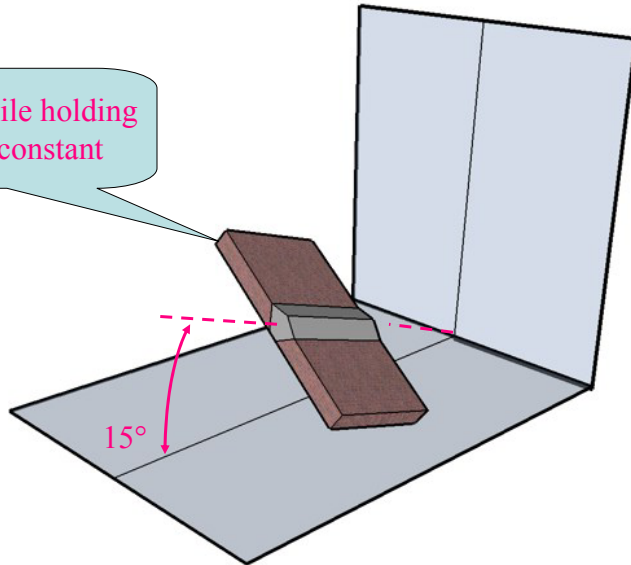
Start here with inclination
Uphill or Downhill 15°
Face of weld upward



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Vertical Position Part 3

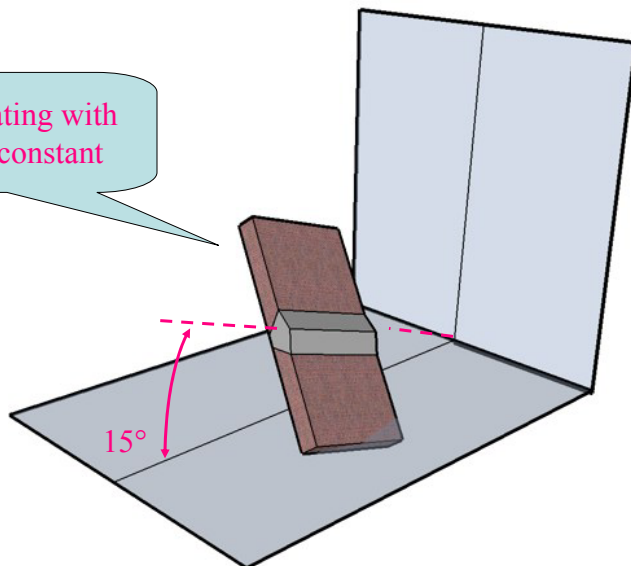
Rotate face while holding
Inclination constant



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Vertical Position Part 3

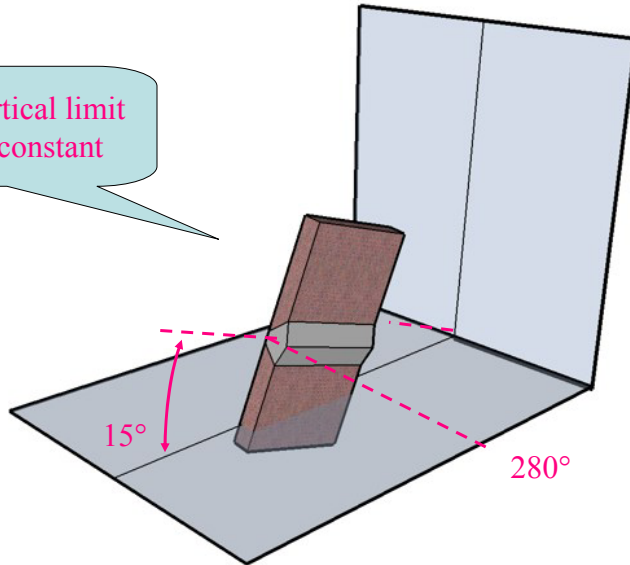
Continue rotating with
Inclination constant



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Vertical Position Part 3

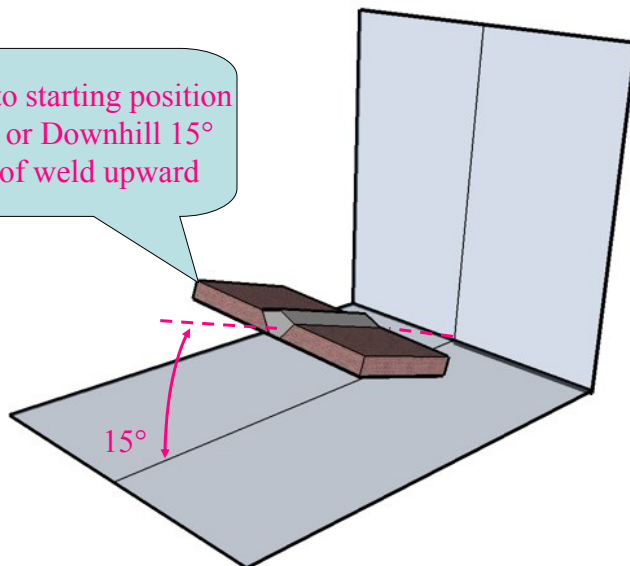
Rotated to vertical limit
Inclination constant



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Vertical Position Part 3

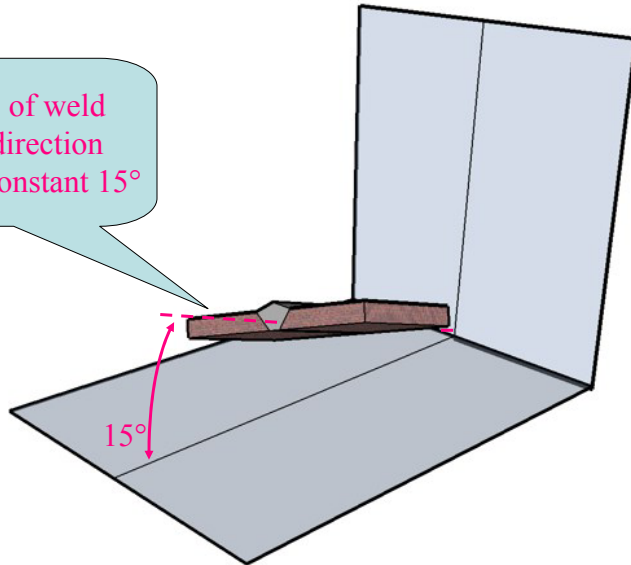
Return to starting position
Uphill or Downhill 15°
Face of weld upward



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Vertical Position Part 3

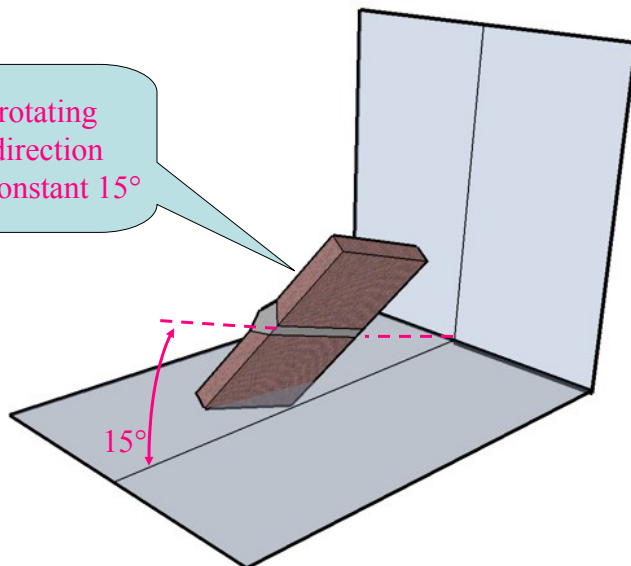
Rotate face of weld
Opposite direction
Inclination Constant 15°



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Vertical Position Part 3

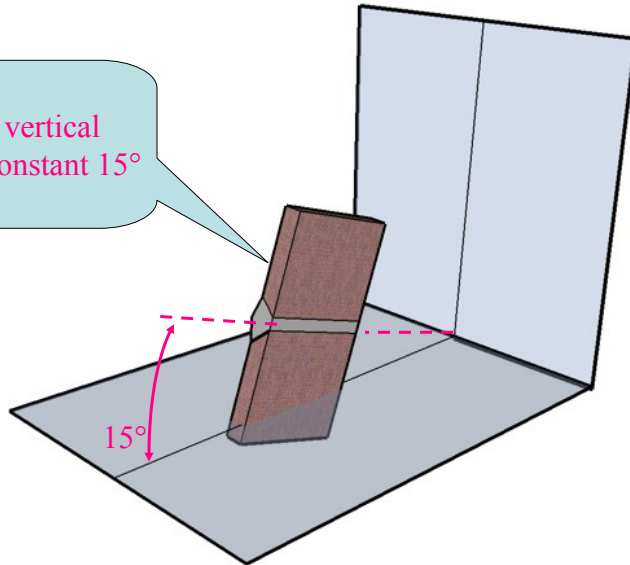
Continue rotating
Opposite direction
Inclination Constant 15°



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Vertical Position Part 3

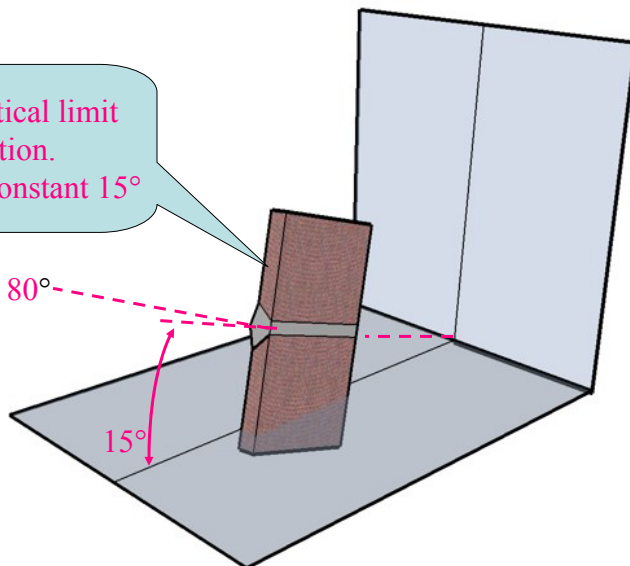
Plate near vertical
Inclination Constant 15°



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Vertical Position Part 3

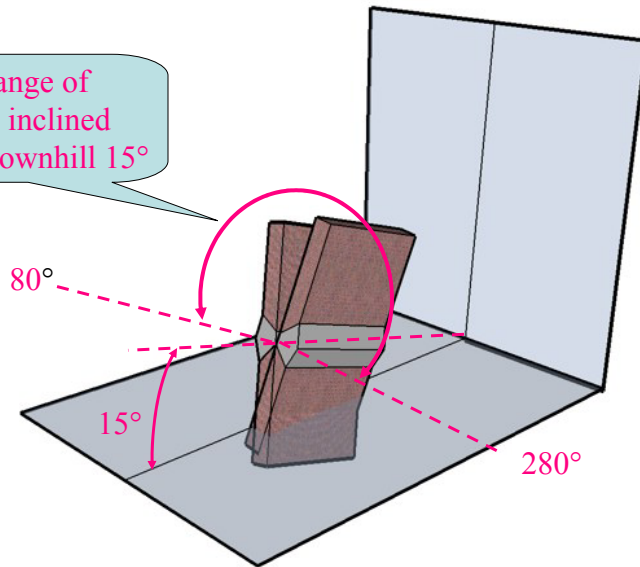
Plate at vertical limit
of rotation.
Inclination Constant 15°



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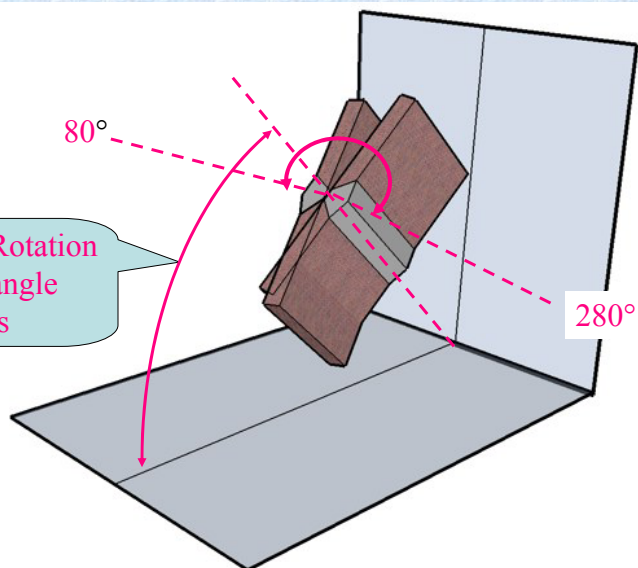
Vertical Position Part 3

200° Range of
Rotation inclined
Uphill or Downhill 15°



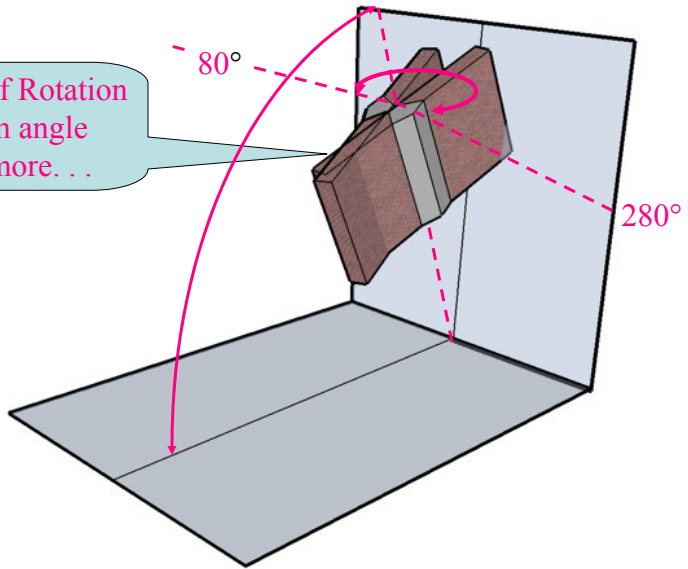
Vertical Position Part 3

200° Range of Rotation
Inclination angle
Increases



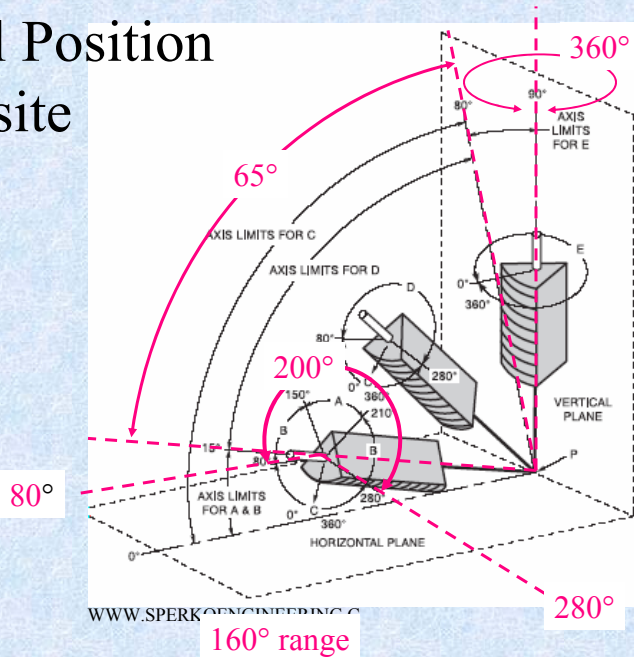
Vertical Position Part 3

200° Range of Rotation
Inclination angle
Increases more. . .



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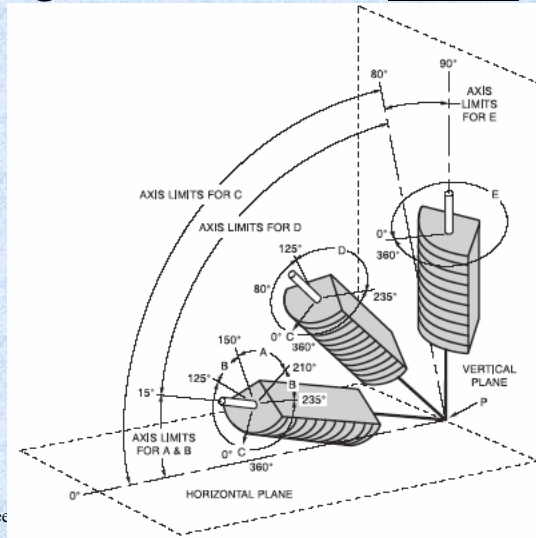
Vertical Position Composite



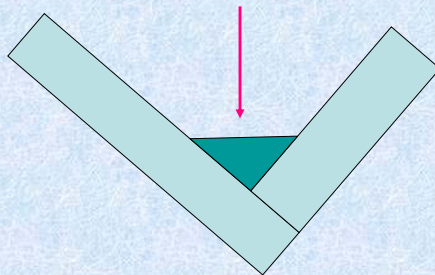
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160° range

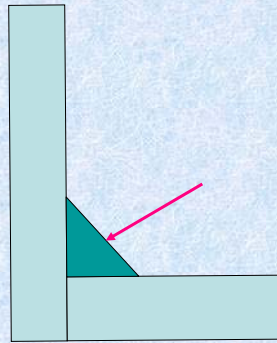
Welding Positions for Fillet Welds



Flat Fillet Weld



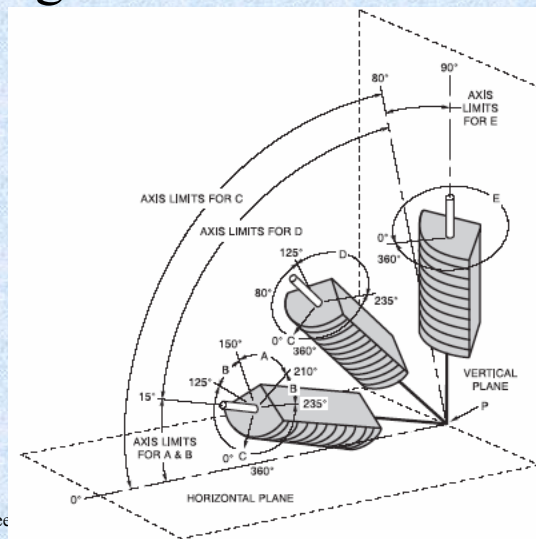
Horizontal Fillet Weld



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Welding Positions for Fillet Welds



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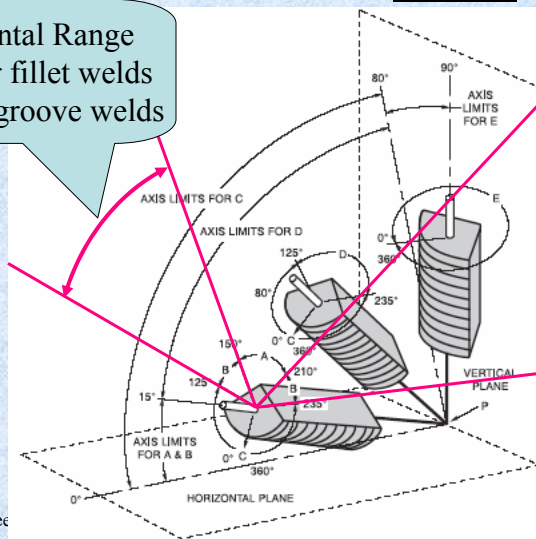
Welding Positions for Fillet Welds

Tabulation of Positions of Fillet Welds

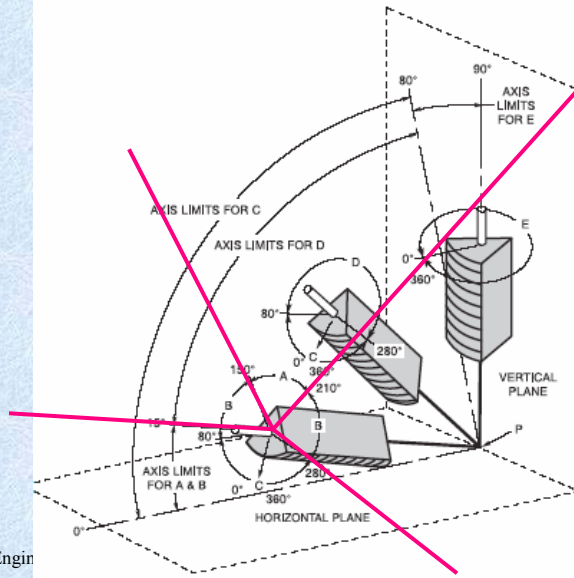
Position	Diagram Reference	Inclination of Axis	Rotation of Face
Flat	A	0 to 15°	150 to 210°
Horizontal	B	0 to 15°	125 to 150°
Overhead	C	0 to 80°	210 to 235°
Vertical	D	15 to 80°	0 to 125°
	E	80 to 90°	235 to 360°

Welding Positions for Fillet Welds

The Horizontal Range
Is smaller for fillet welds
Than it is for groove welds



Welding Positions for Groove Welds



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Questions?

Feedback?

Can you explain the diagrams to
your friends?

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